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SLOW MURDER

The deadly story of vehicular pollution in India

Centre for Science and Environment

Study directed by **Anil Agarwal**
Written by **Anju Sharma** and **Anumita Roychowdhury**

State of the environment
S E R I E S

In an effort to disseminate information and create awareness amongst our readers about different environmental issues, the Centre for Science and Environment has launched a series of booklets on the state of the environment.

The State of the Environment Series deals with indepth studies and critical analyses of various national and international issues on environment.

This booklet, the third of our series, is an indepth study on the phenomenon of vehicular pollution, which investigates the reasons that have made vehicular pollution an alarming menace in our cities, and recommends measures to curb it.

This will be followed by our fourth publication which assesses the environmental agenda of India's political parties. It measures the distance between politicians' green promises and a lopsidedly developed world wherein life's multiplicity is reduced to the exigencies of the blindly garnered vote.

November, 1996

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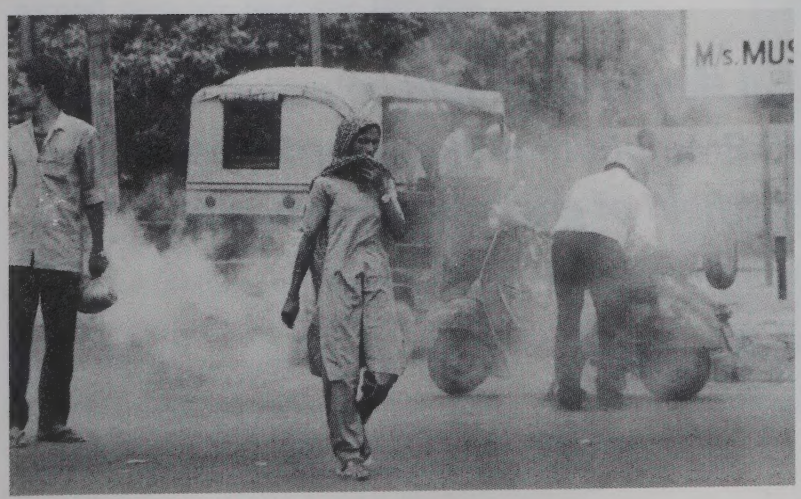

Despite legislative and institutional frameworks and a pollution control statement, precious little has changed on the Indian pollution front which continues to worsen rapidly over time.

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The dramatic rise in air pollution in most Indian metropolises over the last one decade is a direct result of an inefficient state, both in terms of its balancing responsibilities — that is, bringing about a balance between environment and development, and precautionary activities — that is, taking action before the damage is done.

◆

Our study reveals that vehicular air pollution is the result of a combination of bad vehicular technology, poor fuel quality, poor vehicular maintenance and non-existent traffic planning.

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If making money while destroying the environment is an environmental crime, then should not eminent industrialist Rahul Bajaj be declared as India's Environmental Criminal Number 1? After all, Bajaj Auto's, two- and three-wheelers are responsible for much of the urban pollution in India.

◆

The Indian Council of Medical Research should be called the Indian Council for State-sponsored Promotion of Slow Murder because of its total neglect of the field of environmental health.

Introduction

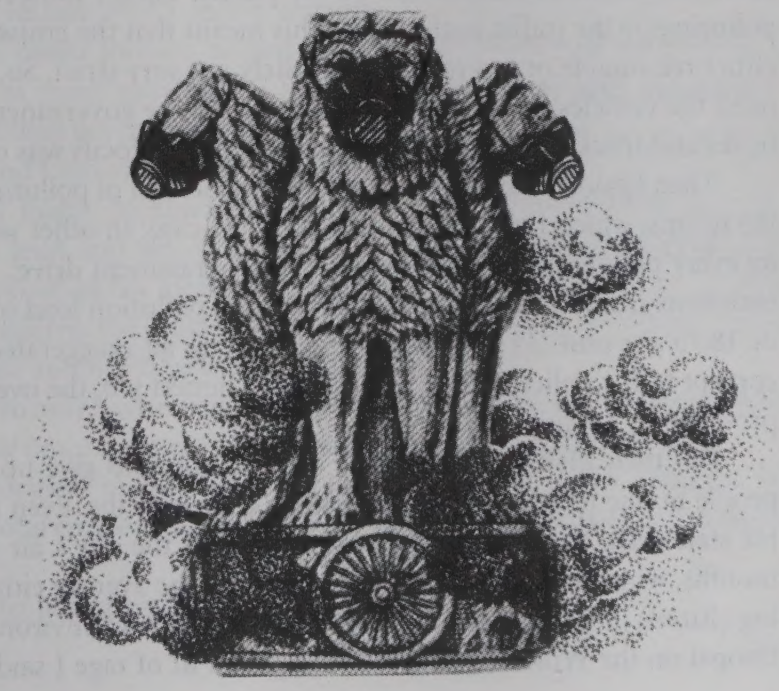
by Anil Agarwal

In the late 1960s, eminent economist Gunnar Myrdal in his famous treatise, *The Asian Drama,* had described the nations of South Asia as 'soft states'. In other words, these nations have governance systems in which the stated policy is at variance with the implemented policy. There is no reason to believe that 25-30 years later — as India is about to enter the 21st century, with all the complexities arising out of a liberalised and growing economy, heavy population density, intense poverty and considerable pressure on natural resources — much has changed in terms of governance systems.

The government has repeatedly stated its interest in pursuing a path of economic development that does not lead to environmental harm. Over 20 years ago, soon after the Stockholm Conference, the country had enacted the Water Pollution Control Act in 1974 and the Air Pollution Control Act in 1981. Following the Bhopal disaster in 1984, the government realised that its legislative base was weak to deal with industrial accidents, and enacted the omnibus Environment Protection Act in 1986. During this period, there has also been considerable institutional development with the creation of a full-fledged Ministry of Environment and Forests and a Central Pollution Control Board at the federal level and similar institutions in nearly all the 20-odd states of India.

But despite this legislative and institutional framework, and a pollution control policy statement announced in 1991, precious little has actually changed on the pollution front which continues to worsen rapidly over time.

Environmental management is built on two principles: the balance principle and the precautionary principle. Economic growth, it is now widely recognised, creates environmental problems. Therefore, the state, while promoting economic growth, must use its regulatory and fiscal powers to strike a balance with environmental harmony. What is the point, after all, of owning and moving around in a motor vehicle if you are soon to die of cancer? And, the second principle demands that this balancing action be taken before the environmental damage begins and not after.



The Indian state has not bothered about any of these two obligations. *The dramatic rise in air pollution in most Indian metropolises over the last one decade is a direct result of an inefficient state, both in terms of balancing responsibilities and*

precautionary activities. Delhi and Calcutta are already rated as among the worst polluted cities in the world and many others like Bangalore, once considered a garden city, are rapidly deteriorating.

During the high summer of 1995, I saw a large number of cars, running into hundreds and thousands, line up in the heat in Delhi to check their emission levels. I found that to be a most fraudulent act on the state's part — an attempt to shield its own corruption and incompetence and shove undue blame on the ordinary motorist. Even as an environmentalist, I was not aware of all the contours of this highly technical problem of vehicular pollution. But on the face of it, it seemed a bit imbecilic to think that only vehicular maintenance was at the heart of the problem. First, I knew this was not the key policy measure taken in industrialised countries to reduce air pollution and, second, at various stages people had told me different things that contradicted this harassment of the citizen by the state. At a dinner in Washington DC, the former chairperson of the Gas Authority of India Ltd, Vineet Nayyar, told me, *"Anil, your biggest problem is the quality of fuel that state refineries are supplying the cities. Strangely, none of you environmentalists seem to be taking up that issue."* I had begged ignorance.

While promoting economic growth, the state must strike a balance with environmental harmony. This should be done before the environmental damage begins

Therefore, my first reaction in that June heat was that, as an environmentalist, I must issue a press statement that Delhi's citizens should refuse to get their tailpipes checked unless the government got its act together. After former Environment Minister Maneka Gandhi adopted the environmental gimmick of checking tailpipes in 1991, everybody down to Madan Lal Khurana (former Chief Minister of Delhi) have found it a great publicity stunt to force citizens to get their vehicles checked, without getting their own act together — a scandal, to my mind, more murderous and injurious to public health than the entire *hawala* scandal put together.

The rough calculations I did mentally confirmed how irrelevant the whole thing was. I assumed that 75 per cent of the pollution load in Delhi was from vehicles, that is, the remaining 25 per cent can be attributed to industries and power plants. Then I noticed that every vehicle was not found to be polluting by the traffic authorities. This meant that the emission standards of individual vehicles were either reasonable or too relaxed, definitely not very strict. So, I further assumed that about 50 per cent of all the vehicles in Delhi were actually above the government's norms. In fact, polluting vehicles like buses and trucks were hardly being checked. The focus was on relatively cleaner vehicles like cars.

Then I said, let me assume that this population of polluting vehicles is polluting 100 per cent above the norms, which I very much doubt was the case. In other words, if the emissions standards were met by every polluting vehicle because of this 'harassment drive', we would get a reduction of 50 per cent emissions from each vehicle. And the overall pollution load of the city would decrease by 75x0.50x0.50 or 18.75 per cent. As my ballpark figures were all exaggerated and neither I nor the media expect the corrupt traffic police to do a thorough and honest job, the overall impact on pollution reduction would probably be 2-5 per cent.

But then Madan Lal Khurana was not going to give up his vehicle. And there were many more people in line to get new vehicles within a few months. Even if all those vehicles met the government's lax standards, the total air pollution load and the city's air quality would be the same within a few months, which is what ultimately mattered to the average citizen of Delhi. So why was the state harassing citizens in this manner in the great green name of environment? In fact, during a public meeting in Bhopal on the World Environment Day, in a fit of rage I said that the government is a fraud, and it is

very wrong for environmentalists to allow the government to get away with glory for a 'green' fraud of this kind. I got the feeling that most people did not really understand what I was talking about.

But the fact was that I myself was unsure of the overall problem of vehicular emissions. I, therefore, did some reading and sought an appointment with my friend D K Biswas, chairperson of the Central Pollution Control Board. He kindly agreed to see me and spent a few hours discussing the problem and the barrage of questions I had for him. I said, we all know that the air quality of all Indian cities is worsening. In many cities, vehicular air pollution is the key culprit, especially in Delhi. But is it because the cars are not 'well-maintained' or is it because we manufacture vehicles that should be banned the very moment they are produced? Or, is it because the government of India is the biggest cheat in the business and its refineries are supplying the worst possible fuel in the world? After all, never expect a monopoly regulator, especially the state, to regulate itself. The Soviet Union is a wonderful example of a country which set the world's strictest environmental standards in writing, but polluted everything without compunction. And indeed, if our own secretaries to the government and ministers were so committed and honest, things all round would have probably been better. Or is it because nobody is really planning ahead to meet the traffic needs of our cities? For instance, Delhi today has no mass transit system. Even the public transport system is built around heavily polluting buses. And so Delhi has more vehicles than the number of vehicles in Calcutta, Mumbai and Madras put together. Isn't it a case of state-supervised SLOW MURDER? Could it also be that we have a crassly materialistic middle class which will stick to its aged vehicles and refuse to phase them out, as happens in most Western countries? So even if new technology is introduced, it will take 15-20 years to make an impact.

Biswas listened to me with great patience, gave me long answers and shared many papers. But it was clear to me that we were staring in the face of a highly complex problem and we needed an overview of the problem before even talking about it. I, therefore, talked to two researchers at the Centre for Science and Environment (CSE) to undertake a detailed study. I prepared an outline and a listing of the range of issues, as I saw them, on a *prima facie* basis. Given the technical character of the issue, there was considerable reluctance — a major reason why the Indian NGO sector remains relatively weak on pollution-related issues, unlike forestry-related issues. But I promised them all help, to answer as many questions as I could, help identify experts who could help, and thus got the team going.

Delhi, which has no mass transit system, has more vehicles than the number of vehicles in Calcutta, Mumbai and Madras put together. Isn't it a case of state-supervised SLOW MURDER?

Well, this report is now before you. And I can assure that you will be shocked even while reading through its highly technical prose. The pollution is already very bad, to say the least and yet, as of this very moment, except for an absolute mish-mash of *ad hoc* ideas, the government has absolutely no coherent policy to address the problem. So expect to live in hell if you live in an Indian city for another 20 years. A hell that will rapidly and progressively worsen. Tokyo may have moved away from its gas masks. But *people in Delhi and other metropolitan cities of India should brace themselves for a wonderful, oxygen-less 21st century.*

Let me first explain why our study focusses on vehicular air pollution and not on air pollution in general. It is because if you looked at the total emission picture of a city in the 1950s or 1960s, you would see three types of emissions:

- from industrial sources, including power plants;
- from vehicular sources; and,
- from household sources.

With the energy market changing, especially in the 1960s and 1970s, the use of kerosene and LPG spread through domestic urban kitchens, and replaced the smoky firewood and coal. Although during winter, one can still see a pall of smoke over slums in north Indian cities, market forces reduced the third component of urban emissions to an insignificant amount by the 1980s.

In 1991, Parliament passed the Air Pollution Act. It is supposed to tackle industrial and vehicular pollution precisely. We know that at least theoretically, controlling pollution from industry is easier. There are numerous technologies like electrostatic precipitators that can help reduce factory pollution. And finally, if that is not possible, pollution controllers can simply insist on relocating the plant to a greener and cleaner locale, however unjust that might be to the settlements near whom the polluting plant would be located. You may remember that the Supreme Court once ordered stone crushers to move out from the fringes of the city because of the offending pollution.

But a city is stuck with its vehicles. They stay with the city and the city lives with them. Thus, they have to be tamed to cut down on pollution. This is the toughest part of urban air pollution control. And, hence, our decision to focus on it.

Now, what does this report tell us? First, that vehicular air pollution is the result of the following combination:

- bad vehicular technology, which means that certain vehicles should not be allowed to leave the manufacturers' gates — you will usually hear about this problem in very abstract language about standards, without understanding how this will affect the air you breathe;
- poor fuel quality, which in India is a real problem because India is generally short on middle distillates (namely, kerosene and diesel). Hence, refineries, to avoid uproars over shortages, will gleefully crack as much of the heavy distillates (namely, bitumen, with which we pave our roads) to get as much of the middle distillates as possible. And as the government not only produces the lethal stuff, but also sets the standards and is responsible for ensuring that the standards are met, we can be sure of a very unhealthy set of practices taking place in the Ministry of Petroleum which amounts to slow murder;
- poor vehicular maintenance, which too is a problem because improperly maintained cars can be polluting; and finally, very, very important,
- non-existent traffic planning because it is not enough to fine-tune individual vehicles; it is even more important to keep a strict control on the total population of vehicles in a city by:
  - promoting non-vehicular mass transit systems so that a large proportion of passenger trips can be undertaken on trains or electric trams;
  - promoting non-motorised forms of personal transport like bicycles;
  - restricting vehicles in congested areas by allowing cars ending with odd numbers to run on one day and even numbers on another day;
  - declaring congested markets and residential areas as pedestrian areas;
  - promoting car-pooling by corporate employees;
  - installing technology like good traffic lights that ensure smooth-moving vehicular traffic;
  - forcing car, bus, scooter and truck owners to phase out old vehicles after some years, when they start becoming heavy polluters, which is common in all industrialised countries; and finally, among hundreds of other options you can innovatively think about,
  - if you happen to be that arch capitalist city called Singapore, which is proud to be a dictatorial but clean settlement, then you tax the hell out of cars so that only millionaires can own them. And all the great marketing managers, media stars and advertising executives, the new hoi polloi of a city growing in a globalised economy like Delhi can play footsie.

The report tells you innumerable things. It does not tell you — as a prescriptive analysis should — what steps should be taken right away, in the medium-term or in the long-term, to cut down pollution to the maximum extent possible. For that certain data that we cannot get hold of, is required. But it does give you an overview of the huge gamut of things involved — how the government is totally disregarding your health interests at every point.

It reveals the games being played in the corridors of the Ministry of Environment and Forests (MEF) and the Ministry of Surface Transport, on the one hand, and the great automobile manufacturers, on the other. It tells you that in the mid-1980s, T N Seshan told the Ministry of Industrial Development that no more new scooter manufacturers should be allowed in India, but nobody even bothered to respond to him. And how, over the years, the vehicular standards have passed from one committee to another, with one characteristic remaining constant every time the ball was kicked — the standards were diluted. We have it in a neat tabular form for you (see page 48).

It tells you of the games being played in the Ministry of Petroleum and the Bureau of Indian Standards. And that when we requested the state-owned agency, Indian Institute of Petroleum, which gets its salaries from taxes that ordinary people like you and me pay, to test samples of Indian vehicular fuel and compare them with international standards, we were told to buzz off, although we offered to pay for the study. I am told, testing fuel quality is no joke. It requires very expensive equipment, which only the petroleum industry and related institutions have. So that's information, knowledge and transparency for you. Which is something we need to tell Vijay Kelkar (secretary, Petroleum Ministry) and T R Baalu (Minister of Petroleum).

It also tells you that India calculatedly imports poor quality crude because it is cheaper, never mind what the sulphur dioxide does to you, as long as the great *sahibs* and *sahibaans* can drive to the *subji mandi.*

It also tells you how poor the whole concept of metropolitan traffic planning is in India — something that you forecast decades in advance and get moving years ahead. It just doesn't exist.

A lot of this may already be evident to you. A lot of this you may have guessed while blowing your nose to work. But for many others, don't ask us for written proof. We have conducted innumerable interviews with interested experts and cajoled, pushed and argued with innumerable officials to tell us something, and this is the picture we have developed. I know journalists love to luxuriate in failure, incompetence and corruption. But truly, this is a story that the Indian media has yet to take up in any seriousness and it has to be told a million times until, despite all the technical complexities, millions of schoolchildren line up the roads in Delhi and Calcutta and tell daddy to walk to work. What good will daddy's wealth be, if they are going to spend their lives wheezing and living under the threat of asthma, cancer and heart disease.

But what this entire story tells me, given the fact that there is no government machinery dealing with this complex problem with earnestness right now, is that the government of India is totally losing its

Table 1 Groups responsible for vehicular pollution

Problem	Regulatory agencies	Interest group
Bad automobile technology	Ministry of Environment and Forests Ministry of Industry Ministry of Surface Transport	Automobile industry
Poor fuel quality	Ministry of Petroleum	State-owned refineries
Bad traffic planning	State/metropolitan transport authorities	
Poor fleet maintenance	State/metropolitan traffic police	Disinterested public
Aging vehicular fleet	State/metropolitan traffic police	Public (resistance to phasing out old vehicles)

ability to deal with complex issues, which really bodes ill for the environment. The Environment Ministry today has no mechanism whatsoever, except for some disorganised boards and expert groups, to analyse or to implement complex issues which span several disciplines and inter-ministerial and Centre-State territorialities. Such issues, even if they are well-analysed, will not move without the involvement of anyone less than the Prime Minister, if they happen to be inter-ministerial in nature.

Let us take the example of vehicular air pollution. As mentioned earlier, our study reveals that a number of factors contribute to vehicular air pollution, which relate to different regulatory agencies and interest groups (see Table 1). As no single solution will provide lasting relief, every problem cited above will have to be dealt with at appropriate time and in appropriate measure, and both a long-term and a short-term strategy will have to be identified and implemented in a phased manner. But despite the seriousness of the problem, the government has no comprehensive strategy to deal with vehicular air pollution. Issues like poor fuel quality are not even publicly known. *The MEF has never produced a comprehensive study outlining all the issues involved and explaining what measures are needed. As a result, many feel that just getting your car checked regularly will solve the problem — this is a total lie.* The government has shown no capacity to take quick decisions on traffic planning or on the regulation of either its own refining industry or the privately-owned automobile industry. And since the problem spans so many state and central agencies, the Pollution Control Board officials only complain about the lack of seriousness amongst other agencies. Many pollution problems arise out of a complex set of problems and will need comprehensive solutions. The MEF cannot do anything about such problems.

Moreover, any good regulator must have the capability to look ahead, especially in a situation where the economy is growing rapidly, to identify emerging disaster areas and take ameliorative action before the disaster actually takes place. The MEF, for instance, does not even have a think-tank which produces studies about emerging environmental problems or analyses of past experiences in natural resources management and pollution control, so that new and more effective strategies can be identified in a multi-disciplinary framework which brings science and economics together. Because such a think-tank would threaten the generalist bureaucracy and the minister, of course, the government has never felt the need for one. I am not aware of a single study prepared and publicly released by the MEF which warns the public of emerging environmental dangers or argues the need for policy revisions.

The MEF is not thus an institution which collects and analyses data, prepares emerging scenarios,

identifies actions and strategies well in advance, and implements them with care and rigour. *Its responses are slow and tardy and begin only when the problem has reached crisis proportions.* One good example in the area of pollution management is the increasing worldwide stress on pollution prevention, rather than pollution control. All over the world, the initial pollution laws aimed at pollution control led to considerable industrial resistance because of the unprofitable investment needed. But over time, countries have begun to realise that pollution prevention which increases energy and material efficiency and reduces toxic waste production, may lead to greater economic efficiency and corporate cost-benefit returns. The MEF has not made any serious effort to understand how such a strategy can be adopted in India and to push the country in that direction. At least, there is no major move in that direction or an effort to get the nation to brainstorm on such issues.

Even its procedures are becoming outdated. For instance, the ministry insists on Environment Impact Assessment (EIA) statements of large industrial projects, which means that if Bajaj Auto sets up a new factory, it will have to provide an EIA that states that the factory is not polluting. But in the specific case of vehicular air pollution, we know that a scooter manufacturing facility will not be very polluting. It is largely an engineering plant. But what is needed to assess the pollution caused by the factory is to subject it to a life cycle analysis (LCA) — in other words, assess the environmental problems caused in the manufacture of scooters from their raw material stage to the stage when they are used on the roads. It was largely with this concept in mind that Seshan is supposed to have told the Ministry of Industrial Development to stop new scooter plants. But no attempt has been made in the MEF to insist on LCA studies.

Moreover, the MEF and the Central Pollution Control Board (CPCB) function in a largely non-transparent environment. These organisations commission a large number of studies on various issues. But these studies are rarely made available to the public, so that they can become a part of the public debate and consciousness. Many procedures common in the West, are not followed. For instance, EIAs of major industrial projects are publicly available there; not so, in India. So the public remains unaware of the dangers posed by the project and the environmental stipulation under which the project has been cleared.

***If making money while destroying the environment is an environmental crime, then would it not be fair to describe eminent industrialist Rahul Bajaj as India's* Environmental Criminal Number 1?**

The MEF has also made no serious efforts to set up mechanisms for an open dialogue with the major stakeholders in environment and development — the NGOs, the public, the industrial leaders — to achieve the key principle of 'balance' I mentioned at the very outset. It follows a highly top-down, bureaucratic and legalistic approach, which ignores the stakeholders and strangulates the energy the public could marshall in favour of the environment, and ends up supporting solutions proposed by specific economic and political agents.

It is clear that the standard system of governance — create a law and then build an institution to implement it — has not worked in the case of environmental issues. But before I move on to the case of vehicular air pollution, let me discuss the role that public opinion can easily play in curbing this menace.

I think that we can get the industry to respond more than the generally lethargic, disinterested, incompetent and corrupt government. When this report was being prepared, I had told our researchers that if making money while destroying the environment can be defined as an environmental crime, then wouldn't it be fair to launch a campaign that describes eminent industrialist Rahul Bajaj as India's Environmental Criminal Number 1, as far as urban air quality is considered? After all, the two-wheelers

and three-wheelers of Bajaj Auto are responsible for much of the urban pollution. Forget the government, what is he doing as a good corporate citizen of the country? *Call T R Baalu or Jai Narain Prasad Nishad environmental criminals howsoever much you may want, they will probably still get their votes.* But such a campaign would greatly hurt the corporate image of Bajaj.

So we decided to directly approach Bajaj with this question and asked him to explain to us what he is doing to solve the problem. I cannot say that I am entirely satisfied with his reply, in the sense that it does not yet give me the confidence that it would solve the problem — and truly, as I have repeatedly argued so far, a whole mix of policies is needed, and, therefore, I support his own frustration with the government. But I did find this eagerness for discussion and dialogue, as his company does remain a key component of the problem, definitely very refreshing. In other words, *Indian industrialists can and will respond to public opinion, if we are prepared to turn the heat on them, as NGOs have indeed done worldwide, especially in industrialised countries.* Well, our interview with him is a part of the report and you can read it for yourself.

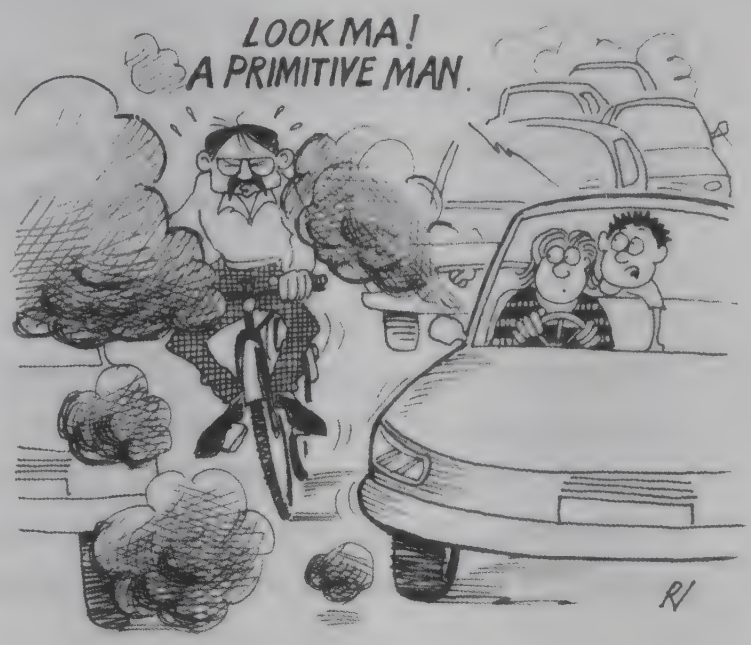
My colleagues have put together a series of recommendations. But I would like to focus on a few that would promote public knowledge, democracy, transparency and better governance which, to my mind, will be the ultimate arbiter of the problem.

First, I would recommend the establishment of a National Vehicular Pollution Prevention Commission, comprising experts and public individuals, with the exclusive task of acting as a think-tank on the state of air pollution, emerging threats of pollution, efficiency of existing regulatory action and programmes needed in the short, medium and long term, but with the right to demand any information from the government. The commission should produce regular reports, including an annual report that provides information on all the above to the public. Though the commission should be a body of the Ministry of Environment, it must not have the minister or the secretary even as a member. I have seen how these officials can destroy a think-tank by stamping out discussions on difficult ideas or simply by not giving it enough time. The commission should have its own budget and staff to conduct and commission regular studies. By this, the Central Pollution Control Board will become, exclusively, an executive agency and the commission will not be burdened with executive functions — otherwise, it would immediately be forced to understate the problem and defend the effectiveness of every executive action. Its aim should be to keep the atmospheric stakeholders informed in a professional and competent manner and stir up public debates. And its job should end there. I am sure that NGOs, citizens' groups and courts will take over further action.

The Supreme Court should declare all pollution-related government documents, whether they exist in the Ministry of Environment or Ministry of Petroleum, as public property

Second, I would recommend similar commissions in every Indian city facing serious pollution problems, so that while the national commission addresses the question of national action, these commissions can pave the way for local action. I don't see these commissions costing a lot, possibly Rs 10-15 crore a year for studies, publications and meetings. But they will make a crucial difference.

Third, I would ensure that these commissions are adequately represented by the medical profession so that appropriate epidemiological studies are conducted regularly. It is a scandal that the only serious study linking air pollution with health was carried out in Mumbai in the early 1980s. Despite the air pollution status of Calcutta and Delhi, nobody knows how cancer and heart disease risks and respiratory problems are growing in these cities. There is public concern about air pollution in the US because every little increase in pollutant levels provokes some study that will immediately publicly reveal the linkage to



health problems. And the effect is such that regardless of the industry or Presidents like Ronald Reagan and George Bush shouting that efforts to further reduce pollution are no longer cost-effective, the public will hear none of it. The backlash against the current Republican campaign to dilute the power of the Clean Air Act is even giving Bill Clinton the chance for a comeback. He mentions environment in every speech and polls show that the same public which elected the Republicans, is listening. But the Indian urban populace remains starved for this kind of information. In fact, I have often wanted to rename the Indian Council of Medical Research — because of its total neglect of an area like environmental health, especially health impacts of the massive pollution of our air, water, soils and food — the Indian Council for State-sponsored Promotion of Slow Murder.

Last, I would request the Supreme Court to declare all pollution-related government documents, whether they are in the Ministry of Environment or the Ministry of Petroleum, including those which record discussions with industry, as public property. Anyone should have the right to see these documents at any point of time to study the kind of compromise being made and at what cost to the public — a kind of Right to Pollution Information Initiative. Because, in literal terms, without such a right, the constitutionally guaranteed Right to Life is meaningless. This is indeed a matter of life and death.

None of this will happen overnight but yet, I think, it can happen. In any case, we have little time to lose. So once you read our report, we would want to hear from you — about how we can work together on this issue which means so much for our own health and for the health of our children, who are growing up in such appalling conditions. As a victim of cancer myself, I cannot but help calling for a public revolution on this issue.

I want to end on a very personal note. In 1991, Maneka Gandhi, who was then the Environment Minister, had asked me during a long journey together to Sukhomajri village in Haryana, what should she do to evoke maximum environmental awareness. I had immediately answered, "Maneka, drive a bicycle to work every day. Your house in Maharani Bagh is not far from Paryavaran Bhawan." She had laughed.

Since my own house in Press Enclave in New Delhi was not far from CSE's earlier office in Nehru Place, I had personally tried to cycle everyday to work. Till I was 26, I had only used a bicycle in my home town, Kanpur. I liked the idea of getting exercise because, otherwise, I would be a typically sedentary office-goer. I found that whereas my scooter would take me 10-15 minutes to get to work, my cycle would get me to work in 20 minutes. That was just great. I was not even wasting time. But within a week I began to wheeze badly, having been an asthmatic for almost 20 years by then, and felt totally drained cycling back on the polluted roads on a winter evening. My doctor asked me to give up the idea of cycling to work. It is still a dream for me to come cycling to work every day, if only the pollution would let me.

Of the total air pollution load from various sources, vehicular pollution contributes to a shocking 64 per cent in Delhi, 52 per cent in Mumbai and 30 per cent in Calcutta.

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Emission controlling standards for new vehicles incorporated in the Motor Vehicles Act (1989) and emission parameters in the Bureau of Indian Standards for fuel were dictated by the automobile industry. The manufacturers pleaded incapacity for drastic improvements and so the standards they follow are lax compared to the rest of the world.

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By introducing catalytic convertors instead of improving engine designs, the automobile industry took the easiest way out to meet the 1996 emission norms. However, there is no regulatory mechanism to test the quality of catalytic convertors and tests reveal that some models fitted with convertors, especially the Maruti Zen, do not even meet carbon monoxide emission standards set for cars without convertors.

◆

Unleaded fuel is manufactured in India without investing in appropriate technology, resulting in increased carcinogenic benzene emissions. The World Health Organisation specifies that there are no safe levels for airborne benzene and yet, benzene levels are not measured in India.

◆

In just seven years, from 1986 to 1993, the number of vehicles in India has shot up by 17 million. An astounding 48.8 per cent of the total number of vehicles in India are registered in Delhi (29 per cent), Mumbai (11.5 per cent) and Calcutta (8.3 per cent) alone.

Chapter I

A Larger than Life Threat

"Who stole the cookie from the cookie jar?"
"Number one stole the cookie from the cookie jar."
"Who me?"
"Yes, you."
"Couldn't be."
"Then who?"
"Number two stole the cookie from the cookie jar."
"Not me."
"Then who?"
"Number three stole..."

Replace the first question of this absurd children's game with "Who's responsible for vehicular pollution?" and substitute numbers one, two and three with the vehicle industry, petroleum industry, and the government, respectively. What emerges is a fairly clear picture of a meeting discussing future policy measures to reduce vehicular pollution and improve the quality of air in Indian metros. While the key groups responsible for vehicular pollution trade accusations to buy time or squirm out of proposed regulations at these meetings, urban Indian citizens breathe less oxygen and more carbon monoxide (CO), sulphur dioxide (SO_2) and nitrogen oxides (NO_X) everyday.

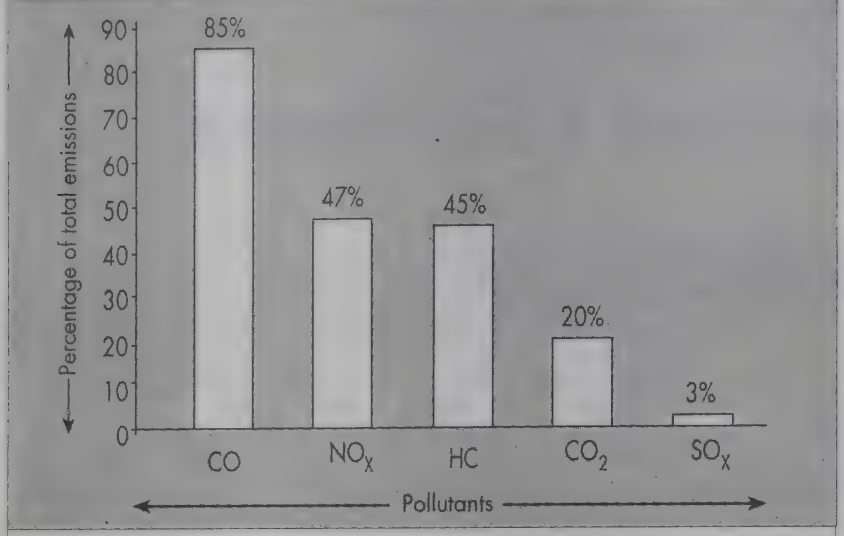
Vehicular pollution is no longer just an intangible threat in cities like Delhi, Mumbai, Bangalore and Calcutta — as the air grows perceptibly darker (see Table 1.1), and respiratory diseases increase in these and other up-and-coming Indian metros, its presence simply cannot be swept under the carpet. According to a World Bank study, *The Cost of Inaction: Valuing the Economy-wide Cost of Environment Degradation in India,* the health costs of ambient air pollution in Delhi alone is US $100-400 million (Rs 350-1,400 crore).[1]

Table 1.1 Estimated emissions in three major Indian metros (1990)

Pollutants (tonnes/year)	Delhi	Mumbai	Calcutta
Sulphur dioxide	46,000	157,000	25,500
Suspended particulate matter	116,000	50,000	200,000
Carbon monoxide	265,000	188,000	177,000
Oxides of nitrogen	73,000	58,000	40,200

SOURCE: 11

Graph 1.1 **World average of the transport sector's contribution to total emissions**



Notes: CO : carbon monoxide NO_X : nitrogen oxides HC : hydrocarbons
CO_2: carbon dioxide SO_X : sulphur oxides

SOURCE: 12

Though industries, thermal power plants and domestic activity also contribute to air pollution in cities, the transport sector is the largest emitter of CO, NO_X and hydrocarbons (HC) into the air (see Graph 1.1). Gasoline-run vehicles contribute most of the CO, HC and lead (Pb), while diesel vehicles are the chief source of particulates and SO_2. Emission statistics indicate that vehicular pollution is responsible for a shocking 64 per cent of the total air pollution load from various sources in Delhi,[2] 52 per cent in Mumbai,[3] and 30 per cent in Calcutta.[4] As much as 97 per cent of HC emissions and 76 per cent of CO emissions in Delhi are from vehicles running on petrol.[1] Presently, vehicles emit 1,300 metric tonnes of pollutants into Delhi's air everyday. This is almost 50 per cent more than 870 tonnes per day (tpd) emitted in 1987[2] — more significantly, this is more than the sum of vehicular pollutants in Mumbai (659.57 tpd), Calcutta (310.62 tpd) and Bangalore (253.72 tpd).[5]

Half-baked efforts

The media in India has carried reports on pollution control drives initiated in the country's metros over the last year. As a part of this drive, vehicles were being randomly stopped and fined if they flouted emission standards. In December 1995, the then Minister for Environment and Forests, Rajesh Pilot, announced the setting up of a Vehicular Pollution Control Mission. In the first phase, the Mission will be so kind as to treat government-owned buses and official vehicles at par with other vehicles and fine them for polluting. But efforts have been restricted to disjointed and piecemeal publicity stunts and nobody is seriously addressing the larger picture.

The measures publicised so far seem to indicate that to control vehicular pollution, it is the vehicle consumers who need to be brought to heel. Poor maintenance definitely increases emissions from old vehicles, and pollution checks are necessary to deal with this problem. But there are other culprits — vehicles manufactured in India have high levels of pollution, even when they are brand new; the fuel sold in petrol bunks across the country is of poor quality and often adulterated, resulting in increased emissions; and the increasing dependence on vehicular transport systems in general, and fuel-and-capacity-inefficient modes of road transport in particular, are taking their toll on atmospheric quality.

Standards for controlling emission levels of new vehicles were incorporated into the Motor Vehicles Act (1989) only as late as 1991, enforcing some sort of quality control on the automobile industry. The existing Bureau of Indian Standards (BIS) for fuel started incorporating emission parameters during the same period. But in both cases, the standards were set according to the terms and conditions dictated by the industry. Both the regulatory authorities and the manufacturers pleaded incapacity to make any

The sharp rise in the number of vehicles is reflected in the alarming rise in air pollution — most vehicles in India are registered in the urban centres and nearly 50 per cent of the vehicles are in three metros alone

Table 1.2 Emission monitoring of catalytic convertor-fitted vehicles in Delhi, 1995

Model	No. of vehicles monitored	Range of CO observed (% of total emissions)	No. of vehicles not meeting 3% CO std
Maruti Esteem	04	0.05-2.6	Nil
Maruti Zen	06	0-5.2	04
Maruti 1000	01	0.4	Nil
Maruti 800	07	0.1-3.2	01
Maruti Van	03	3-7.2	02
Maruti Gypsy	02	0.4-3.2	01
Total	23		08

Note: CO : carbon monoxide std : standard

SOURCE: 13

drastic improvements, and so the standards they follow today are far too lax compared to those elsewhere in the world.

Passing the buck

The skirmishes which take place between the automobile industry, petroleum industry and the government while debating these standards are rarely brought to the notice of the public. When the automobile industry introduced the catalytic convertor (a device in the engine exhaust system which converts harmful gases like carbon monoxide, hydrocarbons and nitrogen oxides into more benign constituents like carbon dioxide, water vapour, nitrogen, etc), for example, it was taking the easiest way out to meet the emission norms set for 1996. Researchers like H B Mathur of the Indian Institute of Technology, New Delhi would have preferred if improvements were made on the engine design. Initially, in a letter to the Central Pollution Control Board (CPCB), the automobile industry agreed to meet the standards with engine modifications but it backtracked later, using it as an opportunity to pass the buck. According to the industry, it could meet the standards only by using catalytic convertors, and this could be achieved only if the government-run petroleum sector provided unleaded fuel (fuel without lead additive).

Sources in the Ministry of Environment and Forests (MEF) are convinced that this was a ploy to put the onus of meeting the standards on the petroleum industry. The automobile industry itself later put down its earlier resistance to 'inexperience'.

Table 1.3 CPCB and AIAM suggested norms for catalytic convertor-fitted petrol vehicles

Cubic capacity (C) of engine in cm^3	Carbon monoxide in gm/km		$HC+NO_X$ in gm/km	
	CPCB*	AIAM**	CPCB	AIAM
C<1400 cc	4.34	5.64	1.50	2.00
C>1400<2000 cc	5.60	7.28	1.92	2.50
C>2000 cc	6.20	8.06	2.18	2.83

Notes: * : Efficiency of catalytic convertor taken as 50% ** : Efficiency of catalytic convertor taken as 35%
AIAM : Association of Indian Automobile Manufacturers CPCB : Central Pollution Control Board
HC : hydrocarbons NO_X : nitrogen oxides cm^3 : cubic centimetre

SOURCE: 14

AMIT SHANKER / CSE

Delhi is entirely dependent on road transport — it has the largest number of buses in India and roads are choked, especially with the introduction of the private 'Redline' and 'Whiteline' buses a few years ago

The petroleum sector, meanwhile, picked up the gauntlet and provided unleaded fuel, although the benefits of using catalytic convertors have been rendered questionable. This is because unleaded fuel is being manufactured in India without investing in appropriate technology, resulting in an increase in carcinogenic benzene emissions. The petroleum sector is safe from reproach so far because, alarming as it sounds, nobody is measuring benzene levels in India as yet; even the WHO specifies that there are no safe levels for airborne benzene. The toxic effects of benzene inhalation by humans include damage to the circulatory, immune, and central nervous systems. Benzene is a known human carcinogen classified as Group1 (definite carcinogen) by the International Agency for Cancer Research (IARC), and known to cause lung cancer, skin cancer and leukaemia.

Meanwhile, even the catalytic convertors do not seem to be working — tests carried out first by the CPCB in May and June 1995, and then by a local environmental group in January 1996, showed that some of the models fitted with convertors, particularly the Maruti Zen, did not even meet CO emission standards set for cars without convertors. The CPCB tested 23 Maruti vehicles with catalytic convertors and eight exceeded emission limits (see Table 1.2). *"There are absolutely no regulatory mechanisms to test the quality of catalytic convertors that are being imported for Indian cars,"* claims H B Mathur of the Indian Institute of Technology, Delhi. *"For all we know, the car companies have been importing boxes in place of convertors."*

So far, there are no norms for cars fitted with convertors. The CPCB and the Association of Indian Automobile Manufacturers (AIAM) have been debating possible standards, with the AIAM, as usual, looking for the easy way out by suggesting lower standards (see Table 1.3).

The lack of source-specific pollution data to pin down defaulters provides another getaway route to

the automobile industry. Pushed into a corner, their response is that vehicles are being blamed for more than their actual contribution to air pollution. The absence of a wide database also impedes the crystallisation of a concrete plan of action.

Sudden spurt in number of vehicles

The sharp and alarming rise in air pollution in India is a reflection of the sharp and alarming rise in the number of vehicles (see Graph 1.2) which shot up by about 17 million in just seven years, from 91,70,000 in 1986 to 2,52,99,000 in 1993.[6] With the world market for automobiles having stabilised over the last few years, after growing steadily for more than three decades (see Graph 1.3), European and Japanese car manufacturers are exploring the large, untapped Indian market. But if we go the Western way, the result could be catastrophic, especially since India lacks the infrastructure needed for accommodating such a rise.

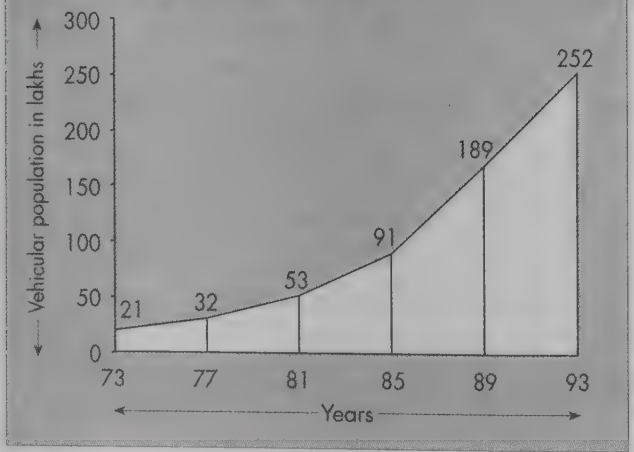
Most of the vehicles in India are concentrated in urban areas — an astounding 48.8 per cent of the total number of vehicles are registered in just three metros; Delhi has 29 per cent of the total, Mumbai 11.5 per cent, and Calcutta 8.3 per cent.[7] In Delhi, the total number of vehicles has increased by 100 per cent since 1986, from 1.07 million vehicles then, to 2.2 million vehicles in 1994.[8] Mumbai's vehicle load accounts for 64 per cent of the vehicles in the entire state of Maharashtra.[7]

A study conducted by CPCB in 1988-89 indicated that the problem is bound to increase as many such metropolises come up, chief among them are Madras, Bangalore, Pune, Ahmedabad and Hyderabad. The quantum of total vehicular pollutants emitted is higher in Bangalore already than in Calcutta. The problem is sharply defined by Bangalore, where recent reports indicate that available road infrastructure has not been able to keep pace with the increased number of vehicles due to rapid urbanisation.[9]

According to a report, *Impact of Road Transportation Systems on Energy and Environment*, prepared by the Tata Energy Research Institute (TERI) in May 1993, one of the main reasons for the large number of vehicles in Delhi is that while Mumbai, Calcutta and Madras have some sort of existing metro rail system, Delhi is entirely dependent on road transport. As a result, Delhi has the largest number of buses in India and the roads are choked, especially with the introduction of the private 'Redline' and 'Whiteline' buses a few years ago, which add to the havoc. Even these buses have not provided Delhi with a reliable means of transport.

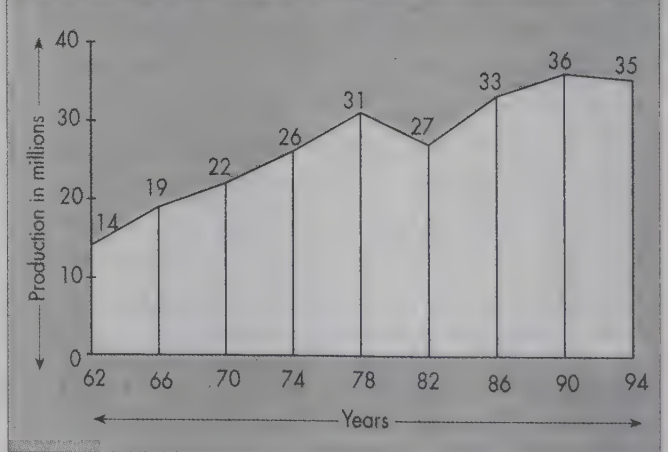
So the citizens of Delhi have resorted to more reliable personal systems, by way of a car, or low-cost

Graph 1.2 **India's vehicle population (1973-1993)**



SOURCE: 10

Graph 1.3 **World automobile production (1962-1994)**



SOURCE: 15

INDIAN EXPRESS

Vehicular pollution is no longer just an intangible threat in Indian metros, and as urban citizens breathe less oxygen and more polluted air, its presence simply cannot be ignored

but extremely polluting two-wheelers. As a result, 67 per cent of the vehicles in Delhi are the most polluting kind, that is, two- and three-wheelers powered by two-stroke engines (engines in which the cycle of suction, compression and combustion, expansion and exhaust is completed in a single revolution of the crankshaft).[8] The situation is similar in the other metros. In Calcutta, for example, almost 44 per cent of the vehicles are two-wheelers.[4] Against 6.2 million two-wheelers in 1986, presently the number of two-wheelers in the country is 17 million.[10]

Urgent solution required

Whether they admit it or not, Indian policy-makers definitely have a problem that must be dealt with immediately. The solutions will have to be multi-pronged and innovative and will need political will and backup.

An environmental performance review of Japan, released by the Organisation for Economic Cooperation and Development (OECD), noted that Japan had achieved the best results among industrialised nations in reducing emissions of harmful air pollutants. This progress, initially triggered off by health concerns in the late 1960s, was achieved through "cooperation by all levels of government and industry and was largely due to the combined effect of major structural changes in the economy, energy efficiency measures, changes in fuel mix and advanced emission control technology," combined with an "ambitious regulatory policy to attain national ambient air quality standards."

The Indian situation can improve only if "cooperation by all levels of government and industry" and an "ambitious regulatory policy" replaces the existing "conspiracy by all levels of government and industry" and an "as-it-suits-us regulatory policy".

Delhi is the fourth most polluted city in the world. And no wonder — the transport sector alone pumps more pollutants into the capital than the sum of vehicular pollutants emitted into Mumbai, Calcutta and Bangalore.

◆

D K Biswas, chairperson of the Central Pollution Control Board states that the sheer volume of traffic in Indian cities can throw all emission control exercises out of gear. In India, private vehicles constitute at least 80 per cent of the vehicles in metros today and during the last decade, the number of two-wheelers in India has increased by 561 per cent.

◆

Vehicular emissions cannot be controlled unless frequent stoppages caused by too many intersections and congested traffic are reduced. Fuel consumption increases by 20 per cent and emissions increase by 25-50 times in diesel vehicles due to constraints in traffic.

◆

In Mumbai, emissions from diesel vehicles are assuming dangerous proportions — nearly 20 per cent of the vehicles are diesel powered which are the main source of particulate emissions. Particulate matter less than 10 microns in size have a high morbidity rate and more than 90 per cent of particulate matter emitted in Mumbai are smaller than 2.5 microns in size and respirable.

◆

The total road length in Calcutta is as low as 6 per cent of the total city area, compared to 10-15 per cent in other Indian cities. Traffic jams and slow moving traffic due to insufficient road space and unfit roads aggravate the problem of vehicular emissions in the city.

Chapter II

Choked Cities

Delhi's inhabitants inhale the most polluted air in the country, and vehicular pollution is responsible for 64 per cent of the pollutants which make it so.[1] *According to a WHO report published in 1994, the Indian capital is the fourth most polluted city in the world. And no wonder, the amount of pollutants the transport sector pumps into Delhi is more than the sum of the vehicular pollutants emitted in Mumbai, Bangalore and Calcutta* (see Table 2.1).

After Delhi, these three cities have the maximum air pollution, followed by Ahmedabad. In Mumbai, vehicles are responsible for 52 per cent of the total atmospheric pollution,[2] while in Calcutta, their share is about 30 per cent.[3] There are several reasons for high vehicular pollution levels in Indian metros. The obvious one, of course, is the number of vehicles plying. In Delhi, as in other metros, the growth in the number of private vehicles is related to the lack of adequate public transport and unplanned urban development. Poor traffic planning and management also contribute to the problem considerably. In cities like Calcutta, lack of road space and badly maintained roads slow traffic and increase emissions.

Traffic composition

Urbanisation has a strong bearing on the travel demands in the country. Higher incomes, mobility, expanding cities, and the proliferation of employment centres have increased the demand for motorised transport, resulting in a disproportionately high concentration of vehicles in urban centres. Irrational distances between homes and places of work, greater incentives for private transport, and inadequate and poor quality public transport has further aggravated the problem. *The Tata Energy Research Institute (TERI) estimates that of the total travel demand in 17 selected cities in India, the four metros will generate nearly 56 per cent by 2010. This trend will negate any other efforts made to improve air quality, and needs to be dealt with urgently.* In 1991, for example, the vehicle population in India comprised

Table 2.1 **Comparison of traffic situation in three Indian metros (1993-94)**

City	Contribution of vehicular pollution (%)	Vehicular pollution (tpd)	% of total vehicular population in India	Cars as % of total traffic	2-whls as % of total traffic	% of travel trips by buses	% of total trips by suburban rail	Average peak hour speed (kmph)
Delhi	64	1,300	29	20	69	62	1.0	10-15
Mumbai	52	659.57	11.5	42	38	72	30	15-20
Calcutta	30*	300.62	8.3	40	44	34	20	14

Notes: 2-whls : two-wheelers 3-whls : three-wheelers tpd : tonnes per day
kmph : kilometres per hour * : for 1988-89

SOURCE: 11

AMIT SHANKER

The number of two-wheelers in India has shown a 561 per cent increase during the last decade

about 14 million two-wheelers, 2.9 million cars, jeeps and taxis, and 1.7 million buses and goods vehicles (see Table 2.2). Of these, 29 per cent were concentrated in Delhi, 11.5 per cent in Mumbai, and 8.3 per cent in Calcutta.[4] "The sheer volume of road traffic in cities can throw emission control exercises out of gear," according to Central Pollution Control Board (CPCB) chairperson, D K Biswas.

The dominating fractions of total vehicles are in the personalised transport sector. The number of two-wheelers in India, for example, showed a 561 per cent increase between 1981 and 1993. In comparison, the number of buses increased only by 135 per cent.[5]

Private vehicles constitute at least 80 per cent of the vehicles in metros today.[6] This is reflected in production figures — manufacture of cars and two-wheelers have gone up by 20 per cent per annum,

Table 2.2 **Total registered vehicles in India (1951-93) (in thousands)**

Year (as on March 31)	All vehicles	Two-wheelers	Cars, jeeps and taxis	Buses	Goods vehicles	Others
1951	306	27	159	34	82	4
1961	665	88	310	57	168	42
1971	1,865	576	682	94	343	170
1981	5,391	2,618	1,160	162	554	897
1991	21,374	14,200	2,954	331	1,356	2,533
1993 (P)	25,299	17,026	3,330	381	1,599	2,963

Notes: 'Others' include tractors, trailers, three-wheelers, etc (P) : provisional

SOURCE: 5

Table 2.3 Estimated energy demand in the passenger transport sector (in thousand tonnes)

City	1990-1991			2000-2001		
	Petrol	Diesel	Total	Petrol	Diesel	Total
Delhi	452	270	723	2,523	609	3,133
Mumbai	244	11	255	463	18	482
Calcutta	158	195	352	455	1,147	1,603

SOURCE: 6

while that of buses has increased by only 3 per cent. The TERI report, *Impact of Road Transport Systems on Energy and Environment in Metropolitan Cities*, submitted to the Ministry of Urban Development in 1993, criticised the lopsided industrial policy that lays more emphasis on the production of cars and two-wheelers than of buses.

The composition of traffic on city roads also affects emissions. "The future trend in vehicle growth can have serious implications for emissions and fuel consumption patterns," warns V S N Srinivasan, an energy expert from TERI (see Table 2.3). A large number of private vehicles, for example, are two-wheelers which are cheap and reliable but also high on emissions. During the last decade, while the number of two-wheelers in India has multiplied by a factor of about 5.6, passenger cars have gone up about 2.6 times. An increase in the number of two-wheelers results in increased HC emissions. Two- and three-wheelers with two-stroke engines accounted for 70 per cent of the total unburned HC and 46 per cent of the CO emissions in 1992-93.[7]

Similarly, the growing number of cars in metros, which constitute 42 per cent of the total traffic in Mumbai, 40 per cent in Calcutta, and 20 per cent in Delhi,[6] is responsible for high CO levels in all three cities (see Table 2.4). As mentioned in the earlier chapter, while petrol vehicles emit more CO and HC, diesel vehicles emit more NO_X and particulate matter. *Scientists at the Delhi-based Central Road Research Institute (CRRI) indicate that petrol cars emit 49.61 kg of total pollutants per 1,000 vehicle-km, followed by buses and trucks (38.05 kg), three-wheelers (35.79 kg), two-wheelers (27.29 kg) and diesel cars (3.21 kg). But the proportion of CO in the total emission is highest in the case of petrol cars at 80.62 per cent, followed by three-wheelers (71.32 per cent), diesel cars (34.26 per cent), buses and trucks (33.37 per cent), and two-wheelers (62.29 per cent). Thus, private vehicles account for more total pollutants, CO, and unburnt HC than their share in terms of vehicle-km.*

Lack of public transport

To a large extent, the growing number of private vehicles in metros is related to the lack of a reliable public transport system. In turn, *the low occupancy rate of private vehicles promotes an inefficient use of*

Table 2.4 Estimated vehicular emission load in 1994 (tonnes per day)

City	Particulates	SO_2	NO_X	HC	CO	Total
Delhi	10.30	8.96	126.46	249.57	651.01	1,046.30
Mumbai	5.59	4.03	70.82	108.21	469.9	659.57
Calcutta	3.25	3.65	54.69	43.88	188.24	293.71

Notes: SO_2 : sulphur dioxide NO_X : nitrogen oxides HC : hydrocarbons CO : carbon monoxide

SOURCE: 8

Table 2.5 Occupancy and distances travelled daily in the metros

Cities	Occupancy					Effective distance travelled daily (km)				
	2-whls	Cars	Taxis	3-whls	Buses	2-whls	Cars	Taxis	3-whls	Buses
Delhi	1.7	2.4	2	1.8	47	25	26	55	68	238
Mumbai	1.6	2.6	2	1.8	42	25	26	55	68	239
Calcutta	1.6	2.6	2	1.8	40	25	26	55	68	192

Notes: 2-whls : two-wheelers 3-whls : three-wheelers

SOURCE: 6

vehicle capacity and available road space (see Table 2.5). *The situation will continue to get progressively worse as the travel demand increases* and, according to TERI forecasts, will result in a further increase in the number of two-wheelers in particular. Meanwhile, the share of buses in meeting the total travel demand is likely to go down if present trends continue.

The relative share of public transport in Indian cities varies considerably. Buses are usually the most popular mode of public transport. According to TERI, they account for 72 per cent of the travel trips in Mumbai, 62 per cent in Delhi, and 34 per cent in Calcutta.[6] The suburban railway, meanwhile, caters to 30 per cent of the passenger traffic in Mumbai, 20 per cent in Calcutta and only 1.0 per cent in Delhi.[6]

Increasing use of buses or some other mass transit system would alleviate the pollution scenario. To carry the same number of people over the same distance, a car emits 90 times more CO than a bus, a taxi emits 113 times more, a three-wheeler 60 times, and a two-wheeler 49 times. In terms of HC emissions, a car emits 43 times more, a taxi emits 55 times more, a three-wheeler 121 times more and a two-wheeler 100 times more when compared to emissions from a bus. This is reflected in the pollution profiles of the three metros — Delhi, with the highest two-wheeler population (67 per cent), also measures highest on HC emissions (249.57 tonnes

Table 2.6 Vehicle composition in terms of PCU and congestion level

Cities	Total PCU in 1990-91 (`000)	Vehicle composition in terms of total PCU in 1990-91 (%)							Road length (km)	PCU per km
		2-whls	Cars	Taxis	3-whls	Buses	Trucks	Others		
Delhi	2,312	61	18	0.4	3	3	14	0.004	1,595	1,450
Mumbai	809	35	35	4	3	3	13	7	1,426	567
Calcutta	704	33	27	3	1	7	12	16	840	838

Notes: PCU : passenger car units 2-whls : Two-wheelers 3-whls : Three-wheelers

SOURCE: 6

per day).[8] But in Mumbai and Calcutta, where two-wheelers respectively account for only 38 and 44 per cent of the vehicle fleet,[3] HC emission levels are lower at 108.21 tpd and 43.88 tpd, respectively.[8]

Table 2.7 Absolute values of speed (kmph)

Cities	Arterial	Central area
Delhi	25-40	10-15
Mumbai	25-40	15-20

Note: kmph : kilometres per hour

SOURCE: 6

Insufficient road space

Greater reliance on private transport gives rise to another cause for increased emissions. *Indian cities have inadequate road space which cannot accommodate the rise in the number of vehicles. Traffic jams and congestion impede the flow of traffic, reduce the average speed, and thus increase emissions.* It has been estimated by CRRI scientists that vehicles utilise as much as 20 per cent extra fuel due to constraints on traffic movement. Traffic planners warn that vehicular emissions cannot be controlled unless there is reduced frequency of idling, cruising, and deceleration due to frequent stoppages caused by too many intersections and congested traffic. "During idling, cruising and deceleration, the weight of particulates per cubic metre of exhaust gases is 25 to 50 times higher in the case of diesel vehicles. But during acceleration this increases by 500 to 800 per cent above the average value for petrol engines," says H B Mathur of the Indian Institute of Technology (IIT), Delhi.

Our city roads are already under pressure, with Delhi accommodating 1,450 passenger car units (PCU) per kilometre of road length (see Table 2.6), followed by Calcutta (838) and Mumbai (567). Evidence cited by TERI shows that journey speed is declining rapidly in the metros, especially in their central areas (see

ARUN YADAV

It has been estimated that traffic congestion results in 20 per cent more consumption of fuel. Unless idling, cruising and deceleration are controlled, emissions cannot be curbed

Table 2.8 **Average annual emissions compared to national and international standards ($\mu g/m^3$)**

	SO_2	NO_2	SPM
Delhi	33	46.0	543
Mumbai	27	26.0	226
Calcutta	62	39.0	394
NAAQS	60 for residential areas 80 for industrial areas 15 for sensitive areas	60 for residential areas 80 for industrial areas 15 for sensitive areas	140 for residential areas 360 for industrial areas 70 for sensitive areas
WHO std	50	100 (US EPA std)	75

Notes: SO_2 : sulphur dioxide; NO_2 : nitrogen dioxide; SPM : suspended particulate matter; $\mu g/m^3$: microgrammes per cubic metres; NAAQS : National Ambient Air Quality Standards; WHO : World Health Organisation; Sensitive areas : Hospitals, national heritage sites like the Taj Mahal

SOURCE: 14

Table 2.7). The Central Institute of Road Transport (CIRT) in Pune, stipulates that the standard requirement for transport in the metros should be 30 per cent of the total area. But actual availability in cities like Calcutta is as low as 6.4 per cent.[6] *Scientists from CRRI are of the opinion that an appreciable improvement in emission levels can be achieved with traffic engineering like intersection improvements, synchronisation of traffic signals, dispersion of congested traffic, and pedestrian control methods.*

DELHI

Dubious distinction

A CPCB pollution inventory of Delhi shows quite clearly that vehicles are the major cause for air pollution in the capital which is also the fourth most polluted city in the world. *An estimated 2,000 metric tonnes of pollutants are released into the atmosphere everyday, gaseous pollutants from vehicles dominating. CO, with an estimated emission level of 1,063 tpd, tops the list, followed by NO_X at 323 tpd, HC at 320 tpd, and SO_2 at 179 tpd.*[9]

Table 2.9 **Total sector-wise emissions in Delhi (metric tonnes per day)**

Pollutants	Transport	Power	Industry	Domestic	Total
Hydrocarbons	310	2	6	2	320
Suspended particulate matter	13	50	60	12	135
Nitrogen oxides	157	143	20	3	323
Sulphur dioxide	11	121	35	12	179
Carbon monoxide	810	8	128	117	1,063

SOURCE: 12

Vehicular emissions outrank even sources of pollution like thermal power plants, industry and domestic coal burning, and account for as much as 64 per cent of the total pollution load in Delhi. Thermal power plants rank second with 16 per cent, industry 12 per cent, followed by the domestic sector at 7 per cent. *Vehicles account for 97 per cent of HC emissions in the air, 48 per cent of NO_X and 76 per cent of CO emissions.*[9]

Most of the suspended particulate matter (SPM) and SO_2 emissions, however, are from the industry and the power sector (see Table 2.9) — 44 per cent of the SPM emitted from anthropogenic activity is from industry, while the power sector is responsible for 37 per cent; an estimated 76 per cent of SO_2 emissions are contributed by the power sector and 19 per cent by industry. Thermal power plants also emit considerable amounts of NO_X, comprising 44 per cent of the total emissions. CO emissions from industry and the domestic sector are 12 and 11 per cent, respectively.[1]

HC emissions are high because of the large number of two-wheelers which form 69 per cent of the total number of motor vehicles registered in the city. While only 6 per cent of the total vehicles are diesel-driven, they account for 19 per cent of the city's total vehicular emissions. Most of the vehicles in the capital have petrol engines that are high on CO emissions. The volume of exhaust pollutants in the city have increased by about 50 per cent over a period of seven years, from 1987-1993, shooting up from 870 metric tonnes to more than 1,300 metric tonnes.[10]

There is a sharp variation in the pollution profile across localities, depending on traffic movement in the area. The air in the main corridors of transit and major intersections is particularly poisoned with a high concentration of gaseous pollutants. The CPCB has recently assessed the impact of

Table 2.10 Air quality at major intersections in Delhi (1992)

Monitoring sites	NO_X	SO_2	CO
Sensitive areas			
AIIMS	83.87 avg ppb	2.25 avg ppb	2.50 avg ppm
LNJP	43.15 avg ppb	2.25 avg ppb	1.10 avg ppm
National Ambient Air Quality Standards	30 $\mu g/m^{3*}$	30 $\mu g/m^{3*}$	1.0 mg/m^{3**}
Mix-use areas			
Azadpur	293.51 avg ppb	7.25 avg ppb	3.59 avg ppm
Ashram	163.96 avg ppb	5.77 avg ppb	3.59 avg ppm
Connaught Place	197.09 avg ppb	13.25 avg ppb	5.52 avg ppm
Dhaula Kuan	314.67 avg ppb	8.25 avg ppb	3.45 avg ppm
Old Delhi railway station	92.35 avg ppb	4.39 avg ppb	1.98 avg ppm
Raja Garden	169.67 avg ppb	5.94 avg ppb	2.58 avg ppm
Shyamlal College	81.64 avg ppb	5.52 avg ppb	2.16 avg ppm
National Ambient Air Quality Standards	80 $\mu g/m^{3*}$	80 $\mu g/m^{3*}$	1.0 mg/m^{3**}
Residential areas			
IARI, Pusa	24.34 avg ppb	1.34 avg ppb	0.65 avg ppm
Laxmi Nagar	82.35 avg ppb	4.14 avg ppb	3.10 avg ppm
National Ambient Air Quality Standards	80 $\mu g/m^{3*}$	80 $\mu g/m^{3*}$	1.0 mg/m^{3**}

Notes:
* : 24 hours
NO_X : nitrogen oxides
CO : carbon monoxide
avg ppm : average parts per million
AIIMS : All India Institute of Medical Sciences
** : for 8 hours
SO_2 : sulphur dioxide
avg ppb : average parts per billion
LNJP : Lok Nayak Jayprakash Hospital
IARI : Indian Agricultural Research Institute

SOURCE: 10

vehicular emissions on the ambient air quality at major traffic intersections in Delhi (see Table 2.10), including:

- All India Institute of Medical Sciences (AIIMS);
- Lok Nayak Jayprakash Hospital (LNJP);
- Residential areas around the Indian Agricultural Research Institute (IARI) on Pusa Road;
- Laxmi Nagar crossing;
- Azadpur crossing;
- Ashram crossing;
- Connaught Place (CP);
- Industrial and mixed use areas in Dhaula Kuan;
- Old Delhi railway station;
- Raja Garden and the Shyamlal College crossings.

The IARI campus was selected as a reference site as well since it has a favourable topography, being situated on a plateau and surrounded by a forested ridge which traps pollutants from the surrounding areas. The crowded skyline and ground-level congestion in other parts of the city inhibits the air from rising naturally, and aggravates the pollution problem.

"We compared the gaseous concentration in the polluted traffic intersections in Delhi with air quality in the IARI campus on Pusa Road, which is relatively free from vehicular pollution," says CPCB chairperson D K Biswas. "The startling difference only confirmed our suspicion regarding the extreme risk exposure of an average Delhiite on Delhi roads." CO concentrations at the IARI campus were found to be as low as 572 to 1,374 parts per billion (ppb) compared to 5,725 to 11,450 ppb at various traffic junctions, and SO_2 levels were between 2 and 5 ppb at the IARI campus, and 13 to 39 ppb at the traffic junctions. NO_X levels were found to range between 33 and 75 ppb at IARI, and 53 to 846 ppb at the

Fuel consumption in Delhi will double by the year 2010, and the load of pollutants will go up by 72 per cent

traffic junctions.[10]

CO levels were found to be always higher than the prescribed standard at traffic junctions. NO_X levels also exceeded prescribed limits at all monitoring locations, except at IARI. The Azadpur and Dhaula Kuan intersections have significant NO_X concentrations mainly due to high density of vehicular traffic. NO_X concentrations were maximum at Dhaula Kuan, followed by Azadpur, Connaught Place, Raja Garden and Ashram. The concentration of both CO and NO_X were found to be alarmingly high in sensitive areas like the AIIMS and LNJP hospitals, and exceeded permissible limits. During peak traffic hours, NO_X concentrations range between 40 ppb and 152.2 ppb, while the permissible limit for sensitive areas is 22 ppb. CO levels ranged between 1.37 parts per million (ppm) to 4.63 ppm. The average value was found to be 197.09 ppb for NO_X and 5.52 ppb for CO. Frequent fluctuations were recorded at Connaught Place, Dhaula Kuan, and Laxmi Nagar, since an enormous volume of petrol driven vehicles ply through these intersections.[10]

A TERI study considered five possible scenarios in Delhi to estimate the impact of the transport sector on energy consumption and emission levels by the year 2010:

- a continuation of the present trend or the 'business as usual' scenario;
- an improvement in vehicular speed;
- increase in the share of buses;
- introduction of a mass rapid transit system; and,
- the maximum conservation scenario.

According to the study, if the current trend is allowed to continue, fuel consumption will more than double by 2010, and the load of pollutants will go up by 72 per cent. But if the average journey speed is improved from the current 20 kilometres per hour (kmph) to 40 kmph, there will be an overall 27 per cent saving and an overall reduction of emissions, particularly in the case of particulates, SO_2 and NO_X.[6]

In case the third scenario is implemented, and the share of buses in meeting the total travel demand rises to 78 per cent by 2001, fuel demand will drop by 9 per cent compared to just improving vehicular speed, and the load of pollutants will decline by 8 per cent. But if an electricity-based mass rapid transit system (MRTS) is available to cater to 25 per cent of the projected passenger travel by 2009-10, energy demand will go down by 24 per cent and pollutants will decline by 25 per cent.[6]

TERI also estimated that in case all the changes are implemented, with an improvement in journey speed, an increase in the share of buses, and the introduction of MRTS, there will be a 50 per cent net saving in fuel by the year 2010. Also, SPM emissions will decline by 55 per cent, CO emissions by 50 per cent, HC by 49 per cent, lead by 50 per cent, NO_X by 53 per cent and SO_2 by 54 per cent, when compared to the 'business as usual scenario'. The total vehicular pollution emissions will be only slightly (about 14 per cent) lower than current emissions, thus at least promising no further degradation to the citizens of Delhi, and marginally less polluted air.[6]

MUMBAI

Uncontrolled growth

The monitoring of air pollution in Mumbai is mostly confined to principal pollutants like total suspended particulate (TSP), NO_X and ammonia. The ambient air quality is measured for SO_2, and CO only occasionally. The Mumbai Metropolitan Region Development Agency (MMRDA) is carrying out a World Bank aided project for studying the urban air quality of Mumbai (URBAIR). To inventorise the pollution profile of Mumbai, the project is focussing on TSP particles less than the size of 10 microns in diameter (PM10), SO_2 and NO_X from different sources like vehicles, industry, domestic, power plants,

Table 2.11 Annual emissions from different sources in Mumbai (1992, in %)

Sources	TSP	PM10	SO_2	NO_X
Vehicle exhaust (petrol)	5.0	8.0	12.0	18.0
Vehicle exhaust (diesel)	9.0	16.0	4.0	34.0
Resuspension from roads	40.0	16.00	—	—
Power plant	6.0	10.0	33.0	30.0
Industry	7.0	10.0	48.0	11.0
Domestic	17.0	14.0	1.0	4.0
Marine docks	2.0	3.0	2.0	3.0
Refuse burning	14.0	23.0	—	—

Notes: TSP : total suspended particulate; PM10 : TSP particles less than the size of 10 microns in diameter; SO_2 : sulphur dioxide; NO_X : nitrogen oxides

SOURCE: 13

marine docks, and industrial processes like construction and stone-crushing.

The CPCB assessment of vehicular pollution in Mumbai (1989) failed to estimate the percentage contribution of vehicular emission to air pollution because a complete inventory of the sources of pollution was not available. But a comparison of relative emissions of TSPs, PM10s and NO_X from different sources in the city indicates that emissions from diesel vehicles and resuspension (the dust that rises due to vehicular movement) from roads are assuming dangerous proportions (see Table 2.11). Control of particulate emissions was a priority issue while setting the national emission standards for 1990. Diesel engines are the most important source of vehicular particulate emissions, which include soluble organic fractions, soot, etc. Over 90 per cent of such particulates are smaller than 2.5 micron and are respirable.

According to the Mumbai Municipal Corporation, vehicular pollution in the city has increased, from 398.7 tpd to 1,314.33 tpd between 1977 and 1987.[13] But according to CPCB estimates, it peaked from 583.96 tpd to 659.57 tpd between 1987 and 1992. The discrepancy in data from the two sources is yet another example of how unreliable pollution monitoring in the country is. "We are still in the process of correlating data to arrive at a more conclusive picture," defends Ulhas Joglekar from Aditya Environmental Services, one of the consultants of the URBAIR project. Emissions in the city are

Table 2.12 No. of vehicles in Mumbai (1987)

	1981	1985	1991
Cars	180,334	228,122	299,289
Utility vehicles	3,677	5,109	6,501
Trucks/buses	41,931	41,935	56,086
Motorcycles	78,474	143,262	242,008
Autorickshaws	4,465	20,555	24,577

SOURCE: 13

Table 2.13 Impacts of pollution on health in Mumbai (1991)

Type of health impact	No. of cases (per year)
Chronic bronchitis	20,000
Bronchitis in children	190,000
Asthma	741,000
Emergency room visits	76,000
Respiratory hospital admissions	4,000

SOURCE: 13

Table 2.14 Cost of health impact of polluted air in Mumbai (current and likely reductions) (1991)

Source category	Mortality (cases)	Respiratory days lost (million)	Health costs in US$ (million)	Equivalent in Indian Rs (crore)
Current	2,765	60	124	425
Health impact can be reduced if:				
Traffic sources are reduced by				
a) 25%	216	4.6	12.3	40
b) 50%	421	9	24.1	80
Domestic sources are reduced by				
a) 25%	64	1.4	3.6	12
b) 50%	121	2.6	6.9	23
Industry sources are reduced by				
a) 25%	466	10	26.7	89
b) 50%	971	21	55.5	185

SOURCE: 13

concentrated along the main corridors of movement and their link network, and according to the distribution of the non-slum population in the city.

NO_X and SPM emissions from traffic-related sources are very high, largely due to resuspension from roads, and the high number of diesel trucks. According to URBAIR consultants, the concentration and distribution from resuspension is proportional to that from traffic. The concentration is 2.5 times more than that from exhaust gases.[13]

Of the 6.2 lakh vehicles on Mumbai roads in 1991, 42 per cent were cars, 38 per cent motorcycles, and 9 per cent trucks and buses (see Table 2.12).[13] About 20 per cent of the vehicles in Mumbai are diesel powered. While the number of autorickshaws increased by 19 per cent, that of motorcycles rose by 12 per cent between 1981 and 1991. Passenger cars and utility vehicles on the road multiplied by 5.2 and 5.9 per cent respectively, whereas the number of trucks increased by 2.9 per cent. There are about 25 cars, 5.5 trucks/buses and 27 motorcycles per 1,000 inhabitants in Mumbai. In the suburbs also, registered vehicles increased by 14.6 per cent during 1981-91.[13] "This trend has a significant impact on hydrocarbon emissions and carbon monoxide emissions in Mumbai, which had been comparatively lower than other metros like Delhi," says Joglekar.

The Municipal Corporation of Greater Mumbai (MCGB) monitors air quality within city limits while the Maharashtra Pollution Control Board (MPCB) monitors air quality in the remaining Mumbai metropolitan region. About 22 sites of industrial, residential and commercial importance are being monitored, including the commercial centres of Worli Naka, Sion, Dadar, Tilak Nagar; the industrial sites of

Table 2.15 Growth of traffic in Mumbai

Cordons	Total vehicles (1988)	Increase (%)	
		1978-88	Annual
Outer	80,370	58	4.7
Mid-suburban	156,400	70	5.5
Island	195,270	15	1.4
Mid-city	229,960	20	1.8

SOURCE: 13

ARVIND YADAV, CSE

Compared to other Indian cities, Mumbai has a more efficient public transport system — the suburban rail, an important component of the system, caters to 36 per cent of total passenger trips

Maravali, Mahul, Mulund, Bhandup, Jogeswari, Saki Naka, Sewree and Anik Nagar; and the residential sites of Mankhurd, Borivili and Supari Tank. Monitoring locations of both residential and commercial areas include Colaba, Parel, Khar, Chembur Naka, and Ghatkopar. MCGB has been monitoring air quality in these areas for the last 15 years.

Unlike Delhi, SO_2 concentrations in traffic junctions in Mumbai are high. The mean value varied from 38 microgrammes per cubic metre ($\mu g/m^3$) to 117 $\mu g/m^3$ during 1991 and 1992, and the maximum value ranged between 80 $\mu g/m^3$ and 162 $\mu g/m^3$. This is above the national ambient air quality standard of 80 $\mu g/m^3$ for such areas.[13]

NO_X measurements at some traffic junctions varied between 56 $\mu g/m^3$ and 175 $\mu g/m^3$, and the maximum went up to 83 $\mu g/m^3$ in Worli Naka to 296 $\mu g/m^3$ at the Victoria Terminus site. URBAIR

consultants point out that the high mean values of NO_X, SO_2 and TSP at traffic junctions indicate the importance of traffic emissions. The monthly mean concentration of lead in 1971-73 ranged from 0.4 $\mu g/m^3$ to 2.4 $\mu g/m^3$. Subsequently, the levels increased, particularly in the eastern suburbs. The highest level observed was 8.4 $\mu g/m^3$ at Dadar in 1985 and 6.4 $\mu g/m^3$ at Parel. The annual mean level of lead showed an increasing trend and during 1980-87, the annual mean level of lead almost doubled.[13]

Some short-term carbon monoxide (CO) monitorings were done between 1984 and 1987 in Mumbai at several roadside sites during peak traffic flow periods. The mean values ranged between 4 milligrammes per cubic metre (mg/m^3) and 21 mg/m^3. Maximum values ranged between 23-29 mg/m^3. This was close to the WHO guideline of 30 mg/m3. In 1991-92 mean value of CO ranged from 5.1 mg/m^3 in Worli Naka to 11.1 mg/m^3 at the Victoria Terminus station. The maximum values ranged between 7 mg/m^3 to 15.6 mg/m^3.[13]

The average suspended particulate matter (SPM) concentration in Mumbai has increased considerably from 200 $\mu g/m^3$ in 1980, to the present 250 $\mu g/m^3$. During 1987, the SPM concentrations in Mumbai were close to 400 $\mu g/m^3$, according to URBAIR reports.[13]

The health impact of pollution in Mumbai has been very severe due to the high concentration of PM10s. The morbidity rate related to PM10 pollution is considerably high (see Table 2.13). Thousands of people have been exposed to the risk of chronic bronchitis and other respiratory diseases with varying degrees of inflictment. Experts from the Norwegian Institute of Air Research, consultants for the URBAIR project, have estimated (see Table 2.14) the social cost of pollution-induced morbidity in terms of medical treatment, loss of earnings and working days at US $186 million (Rs 663 crore). According to them, if pollution from vehicles is reduced by about 50 per cent, health cost can be brought down by about US $24.1 million (Rs 84.7 crore).[13]

The volume of traffic is increasing by leaps and bounds in parts of Greater Mumbai. Traffic planners in Mumbai survey growth and traffic activity by dividing Greater Mumbai into four areas — the mid-city area up to Mahalakshmi, the island area up to Sion, the mid-suburban area up to Malad Creek-Powai Lake, and the outer area up to the Dahisher-Thane limit.

The maximum increase in passenger vehicles has occurred in the suburbs and the outer periphery of Greater Mumbai, mostly because two-wheeler traffic has increased by about 200 per cent in the outer area, and private car traffic has increased by 20 to 30 per cent over the decade. Autorickshaws have

Table 2.16 Trips by occupational groups in Mumbai (%)

Service groups	Mass transport	Car and taxi	Personal vehicles
In government			
Bombay Island	94.5	2.9	2.6
Suburbs	95.9	1.6	2.5
In private			
Bombay Island	93.9	3.7	2.4
Suburbs	95.7	1.8	2.5
In industry			
Bombay Island	95.6	0.8	3.6
Suburbs	97.1	0.5	2.4
Self-employed			
Bombay Island	70.1	25.0	4.9
Suburbs	83.6	11.2	5.2
Students			
Bombay Island	96.1	3.2	0.7
Suburbs	97.4	1.0	1.6
Others			
Bombay Island	87.7	11.5	0.8
Suburbs	78.3	8.7	2.3

SOURCE: 2

largely replaced taxis in the suburbs during the same period (see Table 2.15).

Due to inadequate road space and overcrowding, the average traffic speed along the main traffic corridors has declined considerably. The average speed of traffic in the western corridor has decreased from 50 kmph in 1962 to 20-30 kmph in 1990. In the eastern corridor, the decrease has been from 30 kmph to 15 kmph. With 1,635 km of road length in the 438 sq km of the Mumbai metropolitan region (including the city and the suburbs), there is dense traffic movement.

No comprehensive study has been made on the impact of traffic planning on emission levels, but P S Pasricha, inspector general of police (Traffic), Mumbai, claims that state initiative at organising traffic has made an appreciable impact on pollution levels in the city. The steps taken include relocating commercial and storage activities out of the city centre, and checking unplanned growth of industry inside city limits. Some of the activities of the Mumbai Port Trust, for example, were shifted to Nhava Sheva in New Mumbai. "This has brought down the movement of trucks in Mumbai by about 40 per cent," claims Pasricha. Similarly, offering tax incentives to industries to locate and relocate outside Mumbai has helped check congestion.

The very high concentration of commercial and office activities in the island city continues to cause concern to Mumbai's traffic planners. "About 10 lakh people hold jobs in an area of only 2 sq km around Nariman Point in Mumbai," says Pasricha.

The state government is now thinking of ways to discourage the use of personalised vehicles. Parking fees have been hiked for the key areas, and special coaches are being planned for the executive class. Pasricha says it is more important to increase occupancy per vehicle. He estimates that the present average occupancy of a car is about 1.6. At this rate, while 700 buses with a capacity of 80 each can carry 56,000 people, 1,000 cars carry only 1,600 people. Yet, compared to other cities, Mumbai has a relatively more efficient public transport system. Almost 80 per cent of passenger trips are provided by public transport of which 44 per cent is by bus, and 36 per cent by suburban rail (see Table 2.16).

But in a recent review of the long-term issues concerning the Indian transport sector, *the World Bank, while criticising the public transport system in Mumbai, warned that unless services are improved, the shift to personal vehicles will continue to increase and this will only compound the problem of vehicular pollution.* The state government is contemplating an MRTS with light railways, electric trolley buses and an expansion of the existing railway network. "But we have yet to work out the cost and applicability of these projects," admits Pasricha.

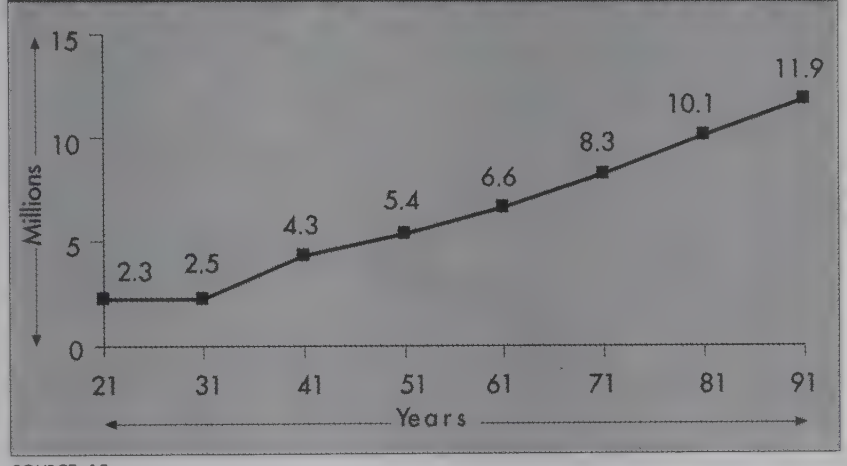
CALCUTTA

An environmentalist's nightmare

"*...don't let anyone tell you that Calcutta is a dying city. A living hell, yes, and proud of it, thank you.*" — a Calcuttan.

Calcutta evokes extreme reactions. The string of literary eulogies published over the last decade bear testimony to its otherwise elusive attraction. But it is also an environmentalist's nightmare, an ecological disaster in every conceivable way. Administrative systems are cracking under the pressures of overpopulation and space is scarce. The population density of Calcutta is more than any of the other Indian metros — the population of the Calcutta metropolitan area has gone up from 8.3 million in 1971 to 11.86 million in 1991 (see Graph 2.1). The city is covered in a gloom of pollution and its traffic is bursting at its seams.

Graph 2.1 **Population growth in Calcutta (1921-91)**



SOURCE: 15

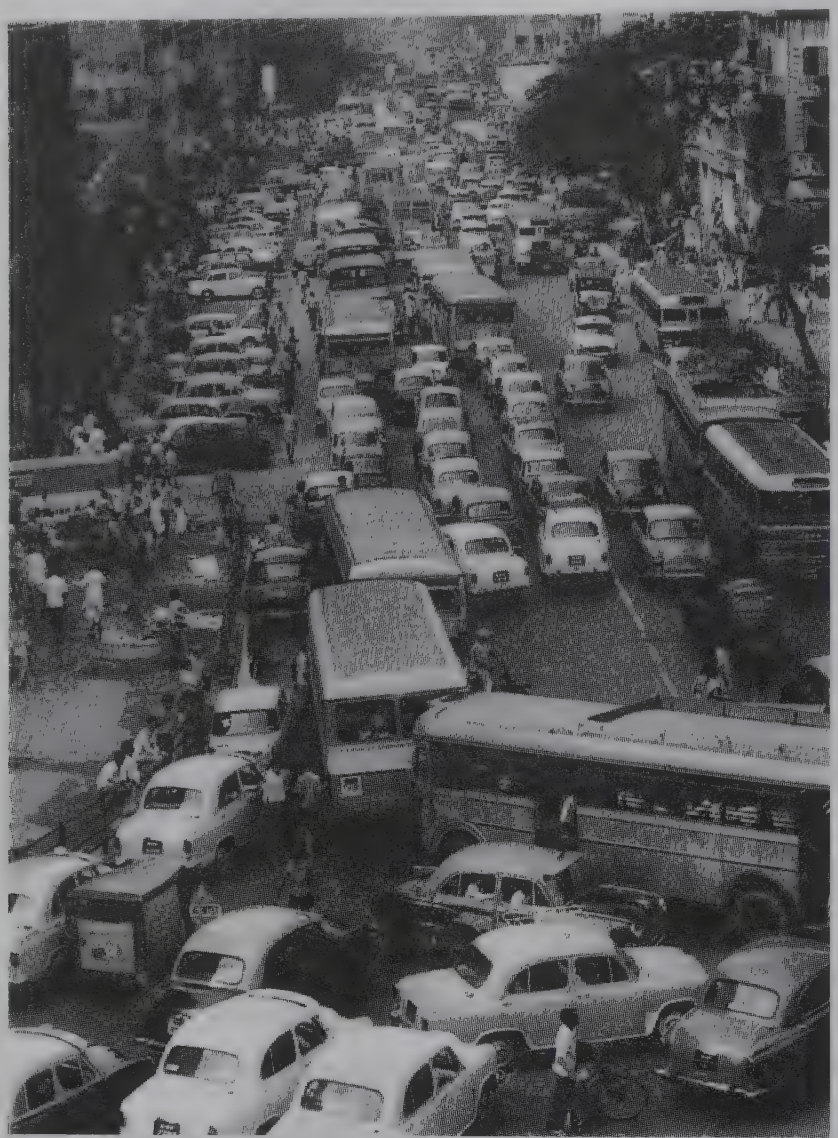
Traffic problem in Calcutta seems to be on its way to acquiring the dimensions of cities like Bangkok, where commuters more or less live in their vehicles, bathing and getting dressed for work while inching their way through nightmarish traffic jams. Calcutta's citizens already spend hours gulping

Table 2.17 **Gross pollutants emitted from different sources in Calcutta (metric tonnes per day)**

Source	Year	SPM	SO_2	NO_X	CO	HC
Industrial sector	1973-75	107	12	7	2	31
	1985	107.5	11.5	7.3	2	31.3
Thermal power plants	1973-75	155	15	19	3	1
	1985	150	46	17.2	2.3	1.1
Transport sector	1973-75	8	1	26	1.3	13
	1985	1	1.3	15.6	138.7	18.3
Domestic sector	1973-74	16	6	4	33	19
	1985	25.3	5.9	7.2	33.7	8.4

Notes: All figures are in metric tonnes per day
SO_2 : sulphur dioxide
CO : carbon monoxide
SPM : suspended particulate matter
NO_X : nitrogen oxides
HC : hydrocarbons

SOURCE: 3



ANANDA BAZAR PATRIKA

Calcutta's citizens already spend hours gulping down fumes while stuck in traffic jams — although the seriousness of the problem is there for all to see, very little data exists to quantify it

down fumes while stuck in traffic jams (see Table 2.17). Although the seriousness of the problem is there for all to see, very little data exists to quantify it, and the exact picture, like the air, is hazy.

Information on the exact amounts of pollutants in Calcutta's atmosphere is sketchy and incomplete. Studies have been carried out since 1973 by the National Environmental Engineering Research Institute (NEERI), the School of Environmental Studies, Jadavpur University, and the All India Institute of Hygiene and Public Health (AIIHPH). "Their work has been fragmentary and the information is inconsistent in many cases," says Dhrubjyoti Ghosh of the Calcutta Metropolitan Water Supply and Sewage Authority (CMWSSA). He has recently published a report on Calcutta's environment, and the picture he portrays is grim.

The vehicular pollution load in 1988-89 in the Calcutta Municipal Corporation was 310.62 tpd (see Table 2.18), and is estimated to be about 30 per cent of the total pollution load. The major pollutants from vehicles are CO, HC and NO_X, comprising 65 per cent, 15.76 per cent and 17.3 per cent respectively, of the total vehicular pollution load. Petrol driven vehicles were found to be major contributors of CO (87 per cent of the vehicular pollution load) and HC (90 per cent), while diesel vehicles were found responsible for NO_X emissions (97 per cent). Among petrol driven vehicles, two- and three-wheelers, respectively emit approximately 52 per cent and 22 per cent of HC and CO together, and the contribution of four-wheelers is 48 per cent.[3]

While SPM, NO_X and SO_2 levels have been measured fairly regularly, there is little information on CO, heavy metals and HC levels. "We don't have the requisite equipment to measure ozone levels," says Arunaba Mazumdar of AIIHPH.

According to a WHO report, *Urban Air Pollution in Megacities of the World*, transport is the greatest source of CO in Calcutta, accounting for 48 per cent of the total, followed by industry at 34 per cent. The remaining 18 per cent is classified as domestic emissions, which have been decreasing over the years due to changes in fuel use; motor vehicle emissions increased by over 10 times between 1970 and 1990.[16]

The WHO report also laments the fact that there is no monitoring of ambient CO in the city, and no recent studies refer to CO emissions in Calcutta. But NEERI studies undertaken in 1973-74, indicate that of the 176.7 million tonnes of CO emitted in Calcutta's atmosphere every day, 138.7 metric tonnes per day is contributed by the transport sector. Two- and three-wheelers emit approximately 22 per cent of the total emission, while four-wheelers contribute 78 per cent.[3] CO has a deadly effect on humans. It reacts with the haemoglobin of blood to form carboxy-haemoglobin and affects oxygen supply to the brain, thus affecting the central nervous system. It can cause severe physiological changes, and ultimately lead to death.

Table 2.18 Total vehicular emissions in Calcutta (in metric tonnes per day)

Year	SO_2	NO_X	CO	HC	SPM	Total
1977	26.2	12.9	175.6	18.0	7.7	240.4
1985	1.3	15.6	138.7	18.3	1.0	174.9
1987	3.04	45.58	156.87	36.57	2.71	244.77
1988	3.78	53.55	199.84	49.81	3.64	310.62

Notes: SO_2 : sulphur dioxide NO_X : nitrogen oxides
CO : carbon monoxide HC : hydrocarbons
SPM : suspended particulate matter

SOURCE: 3

Transport is also the dominant source of Calcutta's NO_X emissions. In 1970, industry contributed 69

Table 2.19 Average RSPM levels in parts of Calcutta (1991-92, in µg/m³)

Month	Industrial areas				Commercial areas				Residential areas			
	Maximum		Average		Maximum		Average		Maximum		Average	
	91	92	91	92	91	92	91	92	91	92	91	92
January	—	1174	—	472	—	495	—	341	—	635	—	364
February	451	451	287	251	599	299	295	188	—	664	—	243
March	264	317	152	188	336	222	142	139	—	—	—	—
April	—	263	—	163	424	229	285	140	471	—	141	—
May	—	242	—	161	147	1,627	78	459	53	237	36	102
June	—	564	—	386	—	196	—	141	—	189	—	111
July	566	—	147	—	—	—	—	—	208	—	92	—
August	172	591	130	277	210	—	111	—	98	239	54	60
September	311	497	190	186	213	268	101	142	261	425	110	213
October	198	247	146	156	356	529	10	211	282	131	167	56
November	465	315	246	230	290	27	230	253	—	285	—	139
December	599	247	413	155	—	716	—	418	665	625	377	318

Notes: RSPM : respirable suspended particulate matter µg/m³ : microgrammes per cubic metre

SOURCE: 3

Table 2.20 **Composition of vehicles in Calcutta**

Type of vehicle	Per cent
Two-wheelers	44
Cars and jeeps	38
Delivery vans	3
Stage carriages	1
Taxis	4
Tractors	1
Contract carriages	1
Goods vehicles	7
Autorickshaws	1

SOURCE: 3

per cent of NO_X emissions in the city but since then, vehicular NO_X emissions have risen from an estimated 1,825 tonnes per annum in 1970 to 25,550 tonnes per annum in 1990. The main vehicular sources of NO_X are diesel trucks and buses. Although they account for only 10 per cent of Calcutta's motor vehicle population, they are responsible for approximately 90 per cent of the motor vehicle NO_X emissions.[3]

Figures related to NO_X levels in Calcutta reveal a surprising fact — these rose to the maximum value during 1984-85, and have come down since and are now within acceptable guidelines. The WHO report states, "no explanation is available for the decrease in concentrations, though it is possible that meteorological factors such as insulation, frequency of calms and ground-level temperature inversions have influenced annual statistics throughout the 80s." On the other hand, figures for NO_X emissions from vehicular sources, collated from different sources show an increase from 12.9 metric tpd in 1977, to 15.6 metric tpd in 1985 and 53.55 metric tpd in 1988.

SO_2 levels in the city peaked in 1981 but have shown considerable reductions since. Emission estimates calculated by NEERI indicate that industry and power generation are the main sources of SO_2 in Calcutta. The AIIHPH survey, conducted in 1993, puts the contribution of vehicles to SO_2 levels at less than 12 per cent, saying that 71 per cent of SO_2 in Calcutta's atmosphere was from thermal power plants, and 17.7 per cent was from industries. The WHO report on air quality attributes the relatively low SO_2 levels in Calcutta to the low sulphur content of coal used by the two thermal power plants in the region. The report also points out that although there has been a significant decline in domestic emissions, it has been rendered ineffective because of increasing industrial and transport emissions.

The increase in vehicular SO_2 emissions is attributed to the increase in the number of diesel trucks in the city. The bus and truck population of Calcutta and Howrah grew by 78 per cent between 1980 and 1989. Existing information indicates that respirable suspended particulate matter (RSPM) concentrations in Calcutta have crossed permissible levels (see Table 2.19). Estimated anthropogenic SPM emissions were approximately 200,000 tonnes per annum in 1990. The main reason for high levels of SPM is the burning of coal by industries and thermal power plants which accounted for as much as 98 per cent of the 1990 total. Among heavy metals, lead is the main pollutant from vehicles. Lead content of Haldia, which supplies fuel to Calcutta, is lower than that in Delhi or Mumbai at 0.1 grammes per litre (gm/l). However, annual airborne lead levels, monitored by NEERI, were found to be the highest in India, with residential and commercial sites having a value of 0.73 grammes per cubic metre (gm/m^3).[3] Unleaded petrol was introduced in Calcutta in April 1995. It will be a few years before the results of this move are apparent.

Very little work has been done in measuring polyaromatic hydrocarbon (PAH) levels in Calcutta, while ozone is not measured at all. But, according to Ghosh, existing information indicates that even present levels are alarming.

The number of vehicles in Calcutta have risen dramatically over the years. *The 1988-89 CPCB report*

PRADIP SAHA / CSE

Calcutta's pride: The metro rail system, partly commissioned in the mid-1980s, has helped in meeting the traffic demands to a large extent. But, due to lack of funds, the project has run into trouble

attributes the pollution problem in Calcutta to the rise in the number of vehicles, the inadequate and narrow road network, and the linear orientation of the city, which results in a north-south flow of traffic and, thus, congestion during peak hours. Furthermore, government, business and commercial activities are concentrated in the Central Business District, in the heart of the city. The development of the city of Howrah has also increased the flow of traffic into the city. There are buses, local trains, metro rail, tram, taxi, autorickshaw and ferry services in the city, but its transportation needs are met mostly by automobiles as, so far, rail caters to only 20 per cent of the needs.[3] Almost 44 per cent of the vehicles in Calcutta are two-wheelers (see Table 2.20). There are also a fair number of rickshaws and bicycles in the city, which reduce the average traffic speed, thereby contributing to increased emissions. The State Transport Corporation was unable to provide sufficient buses to the city, so a large number of standard and mini private buses ply its streets. The tram services, which occupy a significant portion of the road (about one-third), take care of a notable proportion of the mass transport in the heart of the city. But with their slow speed, limited carrying capacity and low frequency, they are far from satisfactory.

The total road length has not increased significantly in Calcutta during the last decade and has remained as low as 6 per cent of the total city area. In comparison, other metros have 10-15 per cent of their area under roads. Traffic jams and slow moving traffic due to insufficient road space, encroachments

Table 2.21 **Average peak hour speed in Calcutta**

Roads	km/hr
Chittaranjan Avenue	12.0
A P C Bose Road	13.0
Lenin Sarani	18.0
S N Banerjee Road	17.0
Ganesh Chandra Avenue and Mission Row Crossing	12.0
B B Ganguly Street	9.0
Shakespeare Sarani	20.0
Park Street	25.0
A J C Bose Road	14.0
Chowringee Road	17.0
Gariahat Road	19.0
Gurusaday Road	20.0
Sarat Bose Road	18.0
Rash Behari Road	16.0
Hazra Road	14.0
Harish Mukherjee Road	22.0

Note: km/hr : kilometre per hour

SOURCE: 3

by hawkers, parking spaces and dwellers, and unfit roads, aggravate the problem of vehicular emissions in the city. "Traffic moves slowly in Calcutta, and slow moving vehicles emit more carbon monoxide," says Ghosh. The performance related emission factors, for a petrol car, show that a petrol engine emits more CO at low speed. In the case of Calcutta, the maximum peak hour speed of vehicles is as low as 14 kmph (see Table 2.21). Bad road conditions also affect maintenance of vehicles — they get more quickly dilapidated. The Municipal Commissioner of Calcutta, Ashim Burman, claims to have spent Rs 3 crore last year on building roads, but the small contractors hired to build the roads did not do a good job. "These contractors do not have the sophisticated technology needed to build quality roads," says Burman.

No actual study had been conducted but AIIHPH officials report an increasing trend of acute respiratory infections (ARI) among the inhabitants of Calcutta. There has been an increase in the incidence of bronchitis, respiratory troubles, oedema of the lungs, cardiovascular diseases, ischemic heart disease and dust allergies. The situation is worse in winter, they say, when people suffer from irritation of the throat, eyes and nose.[17] *A NEERI study found that the Victoria Memorial is being affected due to an alarming rise in the city's air pollution.*[3]

Like other cities in India, the emphasis has been on pollution control drives where polluting vehicles are fined. The introduction of compulsory pollution control stickers has been a failure. There are 36 auto emission centers in the city, authorised to check vehicles and issue these stickers. But a recent workshop by Calcutta's Worldwide Fund for Nature found that many polluting vehicles nevertheless sported the stickers. The workshop revealed that the biggest defaulters of pollution control norms in Calcutta were state-owned buses, mini-buses and taxis.

In a move to decongest traffic, several roads in Calcutta have been made one-way, and there has also been a prohibition on the entry of heavy-duty freight vehicles for the last two or three years. "These measures have had effect," says deputy commissioner (Traffic), Surajit Kar Purkayastha. "We estimate that the average speed of rush hour traffic has come up from 7 kmph to 14 kmph." Purkayastha says the metro rail system, partly commissioned in the mid-80s, has also helped to a large extent. But, lack of funds, arising partly from subsidised rates to consumers, has caused the project to run into trouble.

To deal with the problem of vehicular emissions in Calcutta, the focus must shift to better traffic management and road maintenance, combined with measures to dissuade the use of transport. The narrow roads in the city cannot be expanded, and can take only so much traffic.

Clear and present disaster

The three case studies of Delhi, Mumbai and Calcutta point out several aspects of vehicular pollution in Indian cities — but the one element that really stands out is the fact that there is a severe lack of even basic pollution data in India. The World Health Organisation (WHO) and United Nations Environment Programme (UNEP) report, *Urban Air Pollution in Megacities of the World,* strongly recommends that *"monitoring activities in the major cities of India should be expanded to cover more pollutants with a wider geographical coverage in order to quantify urban air pollution problems better. Localized air quality assessments should be carried out to identify specific problems and to provide detailed recommendations for pollution abatement."*[16]

It should be a matter of great embarrassment to monitoring agencies in India that in the foggy world of existing data, studies carried out by international organisations stand out in their clarity in stating the extent of the problem. The World Bank study by Brandon and Homman, *The Cost of Inaction: Valuing the Economy-wide Cost of Environmental Degradation in India,* is direct in its definition of the problem when it ties up the impact of pollution to health and health costs.[18] According to the study, more than 40,000 Indians are dying early because of polluted air in cities, and these deaths are costing us between US $170 million (Rs 595 crore) to $1,615 million (Rs 5,652.5 crore) in economic losses.[18] Brandon and Homman have also estimated annual health incidences in other Indian cities due to air pollution (see Table 2.22).

Unless the growth of the three metropolitan cities discussed in this study and other rapidly growing Indian cities is closely matched with careful transport planning, Indian cities are definitely heading towards the disaster path. In fact, the disaster is already here.

Table 2.22 Estimates of annual health incidences in Indian cities due to ambient air pollution levels exceeding WHO guidelines

Cities	Premature deaths	Hospital admissions and sickness requiring medical treatment	Incidence of minor sickness
Ahmedabad	2,979	1,183,033	72,177,644
Bangalore	254	135,887	8,326,282
Calcutta	5,726	3,022,786	179,479,908
Delhi	7,491	3,990,012	241,958,219
Hyderabad	768	420,958	25,177,173
Jaipur	1,145	520,947	31,708,958
Kanpur	1,894	812,381	49,247,224
Madras	863	461,966	27,859,487
Mumbai	4,477	2,579,210	156,452,916
Patna	725	319,242	19,561,109

Note: WHO : World Health Organisation

SOURCE: 18

The Mathur Committee, set up to recommend vehicular emission norms for 1995 and 2000, submitted its report to the Ministry of Environment and Forests in 1991. But the final notification issued by the indulgent ministry in 1993 was a diluted version of the committee's recommendations — the lower limit of the norms was nearly as high as the upper limit suggested by the committee.

◆

Automobile technology in India not only needs updating, some of it needs outright junking. The dated carburettor technology used in several Indian models was discarded a long time ago in the West.

◆

Two-stroke petrol engines account for 65 per cent of the vehicle population and consume 60 per cent of the petrol in India. This engine, a killer in terms of emissions, accounts for nearly 70 per cent of the total hydrocarbon emissions. This is because, a large part of unburned fuel escapes with the exhaust due to the simple design of the engine.

◆

B Sengupta of the CPCB states that 30 per cent of the problem of vehicular emissions is due to bad fuel quality. The primary flaw lies in the fact that the public sector refining industry which manufactures the fuel, also sets standards for its quality.

◆

If new, emission-controlled vehicles are not maintained properly, the 1.8 million new vehicles which emitted only 360 tpd in 1989 per day are likely to emit 13,900 tpd by 1996 since they would have deteriorated due to improper maintenance.

◆

Although only one in every 533 individuals owns a private vehicle, public transport systems in India do not even cater to basic requirements. While cars and two-wheelers are growing at the rate of 18.9 per cent and 11.5 per cent respectively, buses are lagging behind at 9 per cent.

Chapter III

The Pollution Makers

FROM the maze of pointed fingers and raised voices exchanging accusations, CSE has identified four major culprits responsible for vehicular pollution:

- outdated vehicle technology arising from vehicle manufacturers' unwillingness to keep abreast of clean technologies and their successful attempts at getting away with as little design upgradation as they can;
- poor fuel quality produced by public sector refineries that can do as they please because they set their own quality standards;
- poor vehicle maintenance by indifferent consumers and an economic structure that keeps vehicles on the road long after they should have been junked; and,
- poor traffic planning that fails to quantify the oncoming crisis and take firm corrective steps, including discouraging the current suicidal rate of growth of privately-owned motorised vehicles.

Behind the times

Automobile technology in India not only needs updating, some of it needs outright junking. But the industry is used to taking things easy — Hindustan Motors, for example, made no changes whatsoever in the engine design of their Ambassador model for a good 33 years, from 1953 to 1986. The dated carburettor (a device that mixes air and petrol in the desired proportion and supplies it to the engine) technology used in several Indian models was discarded a long time ago in the West, where improved carburettors and fuel injection systems (a system that distributes the fuel more evenly so that more power can be developed and undesirable emissions are reduced) have resulted in 15-20 per cent fuel saving and reduction in emissions.[1] The most commonly used mode of transport in the country, the two-stroke two-wheeler is, in its present form, a killer in terms of emissions and

ARVIND YADAV / CSE

Although automobile technology in India badly needs updating, the industry is used to taking things easy — no change was made in the engine design of the Ambassador car for a good 33 years

urgently needs an alternative. But Bajaj Auto Limited (BAL), the largest manufacturer of two-wheelers in the country, currently celebrating the fact that it has put 10 million such units on the road, spends only 1 per cent of its total turnover on research and development.

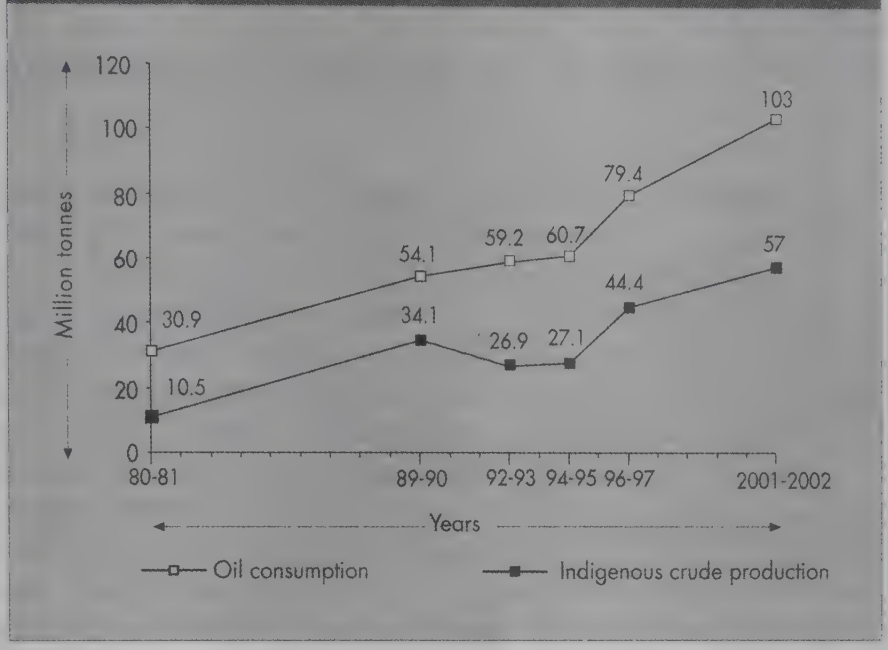
Saying no to stringent emission standards is almost a gut reaction with the automobile industry. Manufacturers raised a hullabaloo about meeting the diluted 1996 emission standards but later admitted that they could, in fact, meet them without too much trouble.[2] The two- and three-wheeler manufacturers were looking for an extension to the 1996 deadline which was denied to them after protracted negotiations. Rahul Bajaj, managing director, BAL, admitted to the Centre for Science and Environment (CSE) in December 1995 that the BAL research and development team had come up with technology modifications which will enable the company to meet the standards in time (see Annexure 1). The norms were issued by the Ministry of Surface Transport only as late as April 1996 with no changes at all and the automobile industry had no alternative but meet them.

The fuel industry is equally indifferent to its contribution to air pollution and imbued with the public sector malaise of apathy. Brutally frank about their position, those in the industry acknowledge that they have not been doing their best. "Why should we invest in upgrading our refining technology without any incentives," says an industry representative.[3] The Ministry of Petroleum occasionally prods them to improve capacity and they do it at the cost of quality. Improving quality will possibly mean reducing capacity and with the import bill already soaring (see Graph 3.1), nobody is particularly keen on the trade-off.

Thoughtful planning

To tackle vehicular pollution and the oil import bill, the transportation sector could plan carefully, targeting a reduction in travel needs and on fuel consumption. Instead of catering unthinkingly to the infrastructure needed by a growing vehicle population, policy-makers need to focus on stemming the growth itself. A World Bank paper, *Global Environmental Impacts of Transport*, states that in order to reduce the environmental impacts of transport, we need to be avoidance-oriented rather than supply-oriented, and that "continuing to provide infrastructure simply to meet projected trends should cease to be part of demand management." The emphasis needs to shift to land-use planning and high capacity-low pollution transport modes. Many cities in the West are restricting the entry of cars in city centres and encouraging non-motorised transport (see Table 3.1).

Graph 3.1 Oil consumption vs self-sufficiency in India



SOURCE: 4

With better public transport facilities, the need for personal transport should reduce and stringent emission standards and enforcements should curtail the problem of poor maintenance.

Table 3.1 Auto-restraint policies around the world

Cities	Action
Leicester, Vienna, Cologne, Strasbourg, Amsterdam and Turin	Cars are banned from entry into city centres.
Hanover	The number of streets on which cars are allowed has been reduced, thereby offering better facilities for pedestrians and cyclists.
Singapore	A car quota system (normally $15,000 a slot), combined with a downtown entry fee, $800 annual road tax and heavy fuel levies make the city one of the most habitable in the world.
Athens	Car entry into city centres has been limited according to number plates.
Mexico City	Daily car entry into crowded areas have been almost halved by allowing entry only according to odd/even number plates.
Freiburg	Subsidised monthly rail passes to discourage car use.
Washington DC metro area, San Francisco and Honolulu	Carpoolers are provided special 'high occupancy vehicle' lanes.

SOURCE: 5

3.1 Outdated technology

A LONG period of waiting ended in disappointment for the automobile industry in April 1996, after the government notified emission standards which the industry had claimed would threaten the fate of some of its products. The industry had registered its protest at a meeting convened by the Ministry of Environment and Forests (MEF) in August 1995, where manufacturers dismissed many of the proposed standards as 'not achievable'. But, as the Central Pollution Control Board (CPCB) chairperson D K Biswas had told CSE, the government did not relent. "Let them stop producing these vehicles now and start when they are ready with the technology," Biswas had said.

When the standards were being discussed, ministry sources had said that several products will have to be phased out when the standards come into force. These included Yamaha RX 100, TVS Shogun, Bajaj Kawasaki RTZ, all petrol driven three-wheelers, Mahindra jeeps and Maruti Udyog Ltd's Gypsy. These models were withdrawn from the domestic market once the norms were issued in April 1996 and are now being sold in countries abroad where emission norms are less stringent. Only Bajaj has stopped manufacturing its Kawasaki RTZ model, which in any case constituted only 1 per cent of BAL's total production, and replaced it with the KB 125 motorcycle.

The rest, with a higher stake in the market, claim they have 'modified' the product to meet standards. Escorts Ltd has withdrawn Yamaha RX 100, which constituted 50 per cent of its production, but promptly replaced it with another two-stroke model, Yamaha RXG 135, which they claim meets the standards. They also claim they have modified TVS Shogun (20 per cent of Escort's total production). Mahindra jeeps and Maruti Udyog also claim they have made modifications. BAL, the largest manufacturers of three-wheelers in India has modified the engine design of its three-wheelers.

Table 3.1.1 Progressive dilution of standards recommended for 1995-1996

Pollutants	H B Mathur Committee (1991) standards for 1995 gm/km	Raju sub-committee (1991) standards for 1996 gm/km	MEF original recommendation (1993) for 1995 gm/km	Final version adopted by MEF (1993) for 1996 gm/km
CO	5.0-9.0	6.2-11.1	7.40	8.68-12.4
HC and NO_X	2.0-4.0	2.7-4.6	1.97	3.0-4.36
	Cold start* measurement	Cold start measurement	Cold start measurement	Warm start*
	Indian driving cycle	Indian driving cycle	European driving cycle	Driving cycle* not defined
	Reference weight of vehicle: grading irrespective of reference weight	Single standard for all vehicles		

Notes: CO : carbon monoxide; HC : hydrocarbons; NO_X : nitrogen oxides; MEF : Ministry of Environment and Forests; * : see glossary

SOURCE: 7

Politics of norms

Considering the ease with which the industry modified the polluting models once they were told to do or die, the fuss they kicked up when the standards were being discussed in August 1995 was entirely out of proportion. Their habit of throwing a tantrum and playing tug-of-war with a very indulgent ministry has often resulted in undermining the objective of improving air quality.

The exercise of fixing pollution norms, meanwhile, was knocked out of its scientific domain and assumed a political hue, with the contending parties — the automobile industry, the petroleum industry and the government — trying to pass on the onus of cleaning up the air to one another in order to reduce the load of each one's own obligations.

The exercise of fixing norms was knocked out of its scientific domain and assumed a political hue, with the contending parties trying to pass on the onus of cleaning up the air to one another

A committee was set up under H B Mathur of the Indian Institute of Technology (IIT), New Delhi, to recommend vehicular emission norms for 1995 and 2000. It based its recommendations on the deliberations of two sub-committees — one for petrol cars set up under S Raju of the Automotive Research Association of India (ARAI), and another for diesel vehicles under B P Pundir of the Indian Institute of Petroleum (IIP). Ever since the Mathur committee's report in 1991, conflicting arguments and counter-arguments have led to endless discussions, needless dilution and uncertainty of proposed standards despite the fact that the automobile manufacturers were represented in this committee and its sub-committees.

But the final notification issued by MEF in 1993 was a diluted version of the Mathur Committee recommendations and even more lenient than the initial proposal put up for consideration by the CPCB. This progressive dilution occurred even though the Mathur Committee rejected the recommendations of the Raju sub-committee — co-experts in the Mathur Committee while criticising them, accused Raju of being sympathetic to the automobile industry and opting for softer norms. The Mathur Committee found that these norms (see Table 3.1.1) were so lenient that more than 60 per cent of the vehicles in India were already within the proposed limit. "What is the point in setting norms which do not aspire to achieve higher targets," exclaims Mathur. "*It is important to set higher targets than what is currently achievable to make technology more responsive.*"

The MEF notification, under pressure from the automobile manufacturers, extended the deadline for meeting the standards from the original date of April 1995 to April 1996 and diluted the norms for carbon monoxide (CO), hydrocarbons (HC) and nitrogen oxides (NO_X) emissions (see Table 3.1.1). The Mathur Committee had recommended 5.0 to 9.0 gm/km for CO and 2.0 to 4.0 gm/km for HC and NO_X emissions, according to the reference weight of petrol vehicles. Following this, MEF first agreed to 7.40 gm/km for CO and 1.97 gm/km for HC and NO_X as a single standard for all vehicles irrespective of reference weight of the vehicles. But the Ministry subsequently, under continued political pressure, finalised the figures at around 8.68-12.4 gm/km for CO and 3.0-4.36 gm/km for HC and NO_X, according to the cubic capacity of the vehicles.

The Ministry further diluted the standards by replacing the cold start (engine condition when engine is started from cold) emission measurement recommended by the committee with warm start (warm condition of the engine when starting), since the industry was not prepared to adopt the required design changes by 1996. Emissions from vehicles is maximum at cold start or before the engine warms up. But Biswas defends the government's stand. "The norms were set in accordance with the technical capability of our industry. This is not adequate but we need to tighten them progressively to give

Up in smog

Separate responsibilities were fixed for vehicle owners, manufacturers and enforcing agencies

Vehicular emissions norms are notified under the Environment Protection Act (EPA) of the Ministry of Environment and Forests and included in the Motor Vehicles Act, 1989, enforced by the Ministry of Surface Transport.[1] Prevailing vehicular emission standards were notified on February 5, 1990. While the rules for the owners of motor vehicles came into force in March 1990, the mass emission standards for the vehicle manufacturers came into force in April 1991. For the first time, there were separate responsibilities for vehicle owners, vehicle manufacturers, and enforcing agencies. These have been further revised for enforcement in 1996 and subsequently in 2000. While responsibilities of enforcing agencies and owners have remained unchanged, mass emission standards for manufacturers have become more stringent.

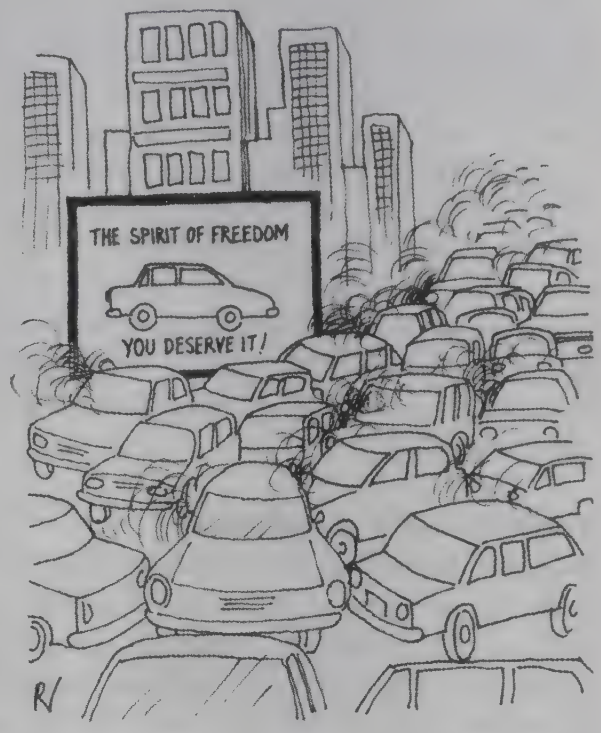
The owners' responsibility under the 1990 rules: The 1990 rules have provided for volumetric concentration of gases in the total exhaust measurement of emissions for vehicles on road. Vehicles can be checked for emissions and owners can be held responsible for not tuning vehicles within the prescribed emission level limit. The limit specified in the 1990 EPA notification has not been changed. Under the current rules, every motor vehicle shall be maintained in such condition that they do not emit smoke, visible vapour, grit, sparks, ashes, cinders or substance. Idling carbon monoxide (CO) emission limit for all four-wheeled petrol driven vehicles shall not exceed 3 per cent by volume. Idling CO emission limit for two- and three-wheeled petrol driven vehicles shall not exceed 4.5 per cent by volume.

Responsibility of the enforcing agencies under the 1990 rules: Any officer, not below the rank of a sub-inspector of police or an inspector of motor vehicles of the transport department, may direct a motor vehicle driver to undergo tests to measure the standard of smoke or the levels of other pollutants, or both. Emissions are to be tested by instruments approved by the state governments.

Manufacturers' responsibility under 1991, 1996 and 2000 rules: For the first time in 1991, mass emission standards were notified for the manufacturers of all petrol driven vehicles. The EPA notification specified the breakup of the operating cycle to be used for mass emission tests and also specified the reference fuel for such tests. Mass emission tests are conducted on a simulated driving cycle consisting of a pattern of acceleration, cruising, deceleration and idling time, and exhaust from each stage is tested for gaseous emission during the operating cycle. Mass emission standards refers to gm/km of pollutants emitted by the vehicle, as determined by the chassis dynamometer test using the Indian driving cycle. The composited pollutant in the emitted gases should be within the prescribed limit under the law.

The mass emission standards for petrol vehicles were set according to reference weight of the vehicles for both the two- and three-wheelers, and for cars. To ensure compliance, designated agencies carry out conformity of production (COP) tests through random selection of vehicles in factories. While norms for COP tests have been set separately, 10 to 20 per cent relaxation has been allowed for mass production. Standards specified for diesel-driven vehicles covered limits for smoke density as the only parameter to be tested and controlled. The maximum mass was specified at 14 gm per kilowatthour (kwh) for CO emissions, 3.5 gm per kwh for HC and 18 gm per kwh for NO_X. It was categorically stated that each vehicle manufactured should be certified by the manufacturers, to indicate that all norms have been conformed with. It should also be certified that the components, liable to affect the emission of gaseous pollutants, are so designed, constructed and assembled that the vehicle during its normal use would meet standards.

industry some time to adjust." The industry was allowed four years to adjust to the 1996 norms which came into force in April 1996.



No comprehensive setup

Experts say that setting standards is not yet a fool proof exercise. Biswas points out that experts have to depend mostly on the experience of other countries and resort to approximation since comprehensive data on the impact of each pollutant is not readily available. Therefore, parameters such as pollution levels, availability of pollution control technology, technological capability of the automobile industry and experiences with pollution control in other countries, become the prime consideration for setting up emission standards. "The entire exercise is based on relative experience and not on absolute targets," says Biswas.

The progressive revision of norms in India have, however, followed a basic logic. The April 1996 norms seek to tighten emission levels by 40-50 per cent over the first ever vehicle emission standard regulation of April 1991. The 1991 standards on petrol vehicles stipulated control only on CO and HC emissions but not on NO_X, and did not include evaporative (mainly volatile fractions of gasoline) and crankcase emissions (unburned/partially burned hydrocarbons that escape the combustion chamber and enter the crankcase from where they are discharged into the atmosphere through vents provided for this purpose).

Subsequent revisions have taken into account the pollution profiles of vehicles. Figures from the Indian Institute of Petroleum, Dehradun, indicate that Indian two-stroke two- and three-wheelers contribute 70 per cent of the total vehicular unburned HC and 46 per cent of the total CO emissions, though their NO_X emissions are negligible. Petrol four-wheelers, on the other hand, emit 25 per cent of the total CO emissions from vehicles, 7.5 per cent of HC and 5 per cent of the total NO_X. Diesel vehicles emit 29 per cent of the total CO, 22 per cent HC and 94 per cent NO_X. Thus, petrol vehicles need stricter CO and HC emission norms, and diesel vehicles stricter NO_X norms. The norms for 1996 and the proposed norms for 2000, have taken this into account to determine emission levels for different vehicle categories.

But the need for a local inventory of pollution to identify the sources of pollution and to work out emission norms according to the magnitude of the problem, is being increasingly felt. P S Pasricha, inspector general of police (traffic), Mumbai, points out, "pollution inventories are important for setting emission norms and organising pollution abatement programmes. They also give traffic planners a clear indication of how to regulate vehicle population in an area to control emissions."

Interestingly, even the industry backs this argument in the hope that such an inventory would show the transport sector in a better light and the responsibility for cleaning up air would be apportioned to other sectors as well. N V Iyer, general manager, Bajaj Auto Ltd, says, "other countries prepare pollution inventories by pinpointing the source and magnitude of pollution. Accordingly, targets are set to reduce pollution to a certain level on the basis of their order of significance. But in India, sectors are singled out without relating it to the overall pollution scenario."

But the transport sector is unlikely to be let off the hook if such an inventory is prepared. Even preliminary attempts by CPCB show that vehicles are largely responsible for poisoning the air in Indian cities with HC, CO and NO_X. A pollution inventory of Delhi, carried out by CPCB for the year 1993-94, for example, shows that among the four major sectors causing air pollution (transport, power, industry and domestic), the transport sector is responsible for emitting about 97 per cent of HC, 49 per cent NO_X and 76 per cent CO into the atmosphere. Only its contribution to suspended particulate matter and SO_2 are low, at 13 and 11 per cent, respectively.[2]

The Association of Indian Automobile Manufacturers (AIAM) claims that manufacturers have been upgrading their technology and have, as a result, "achieved spectacular results on new vehicle emissions, which are down from 360 tpd to 70 tpd, despite an increase in vehicle sales from 1.8 million to 3.5 million over the last 12 years." The real cause for air pollution, it claims, is poor vehicle maintenance and poor quality fuel.[3]

Looking for a scapegoat

In an attempt to buy time and delay the deadline further, the vehicle industry came up with another strategy. It picked on the fuel quality in India and demanded that the industry's commitment to meet emission norms should be backed by a commitment from the government, ensuring supply of unleaded petrol. Besides reducing lead pollution, unleaded petrol is a must for vehicles fitted with catalytic convertors to reduce CO and HC pollution, since leaded fuel reduces the life of the convertors by poisoning the catalyst (substance that alters the velocity of a chemical reaction and may be recovered essentially unaltered in form and amount at the end of the reaction).

The need for a local inventory of pollution to identify the sources of pollution and to work out emission norms according to the magnitude of the problem, is being increasingly felt

The automobile industry had earlier used the non-availability of unleaded petrol as an excuse for its inability to meet the 1996 norms. Informed sources in the MEF, however, indicate that this was a ploy to put the onus on the Petroleum Ministry, based on the presumption that the government would not be able to supply unleaded petrol so soon. The government insisted that other engineering solutions be worked out to meet the 1996 norms. The industry had to accept this, and adopt engineering solutions apart from catalytic convertors. AIAM claims that most of the passenger cars, and 92.5 per cent of two- and three-wheelers manufactured in India, will meet the 1996 norms.

Maruti Udyog Ltd precipitated matters in 1994 by proposing that it would start fitting catalytic convertors in its vehicles even before April 1996, if unleaded petrol was made available in the metros. The rest of the industry was unsure about this move initially but decided to go along, insisting, however, that unleaded petrol be supplied countrywide. Meanwhile, the Supreme Court passed a judgement in 1994, making it mandatory that all new vehicles registered after April 1995, be fitted with catalytic convertors. The government responded by notifying an order to this effect.

Looking back, industry representatives admit that their initial resistance was due to their inexperience. "Industry had taken a different attitude then. It was largely because of our inexperience that we were not sure whether we would be able to achieve those norms. We had to be certain before promising," says Vinod L Doshi, managing director and chairperson of Premier Automobiles Ltd.

The vehicle industry then suggested even more stringent norms for metro areas where unleaded petrol is available. No revised norms were available in 1995 for vehicles fitted with catalytic convertors. So

MEF proposed that the industry test emissions after fitting catalytic convertors, based on which government would finalise new standards for metros. Industry found that it could meet norms that were half-way between the 1996 and 2000 norms (see Table 3.1.2) by using catalytic convertors. While the CO standard is 8.68 gm/km for 1996 and 2.72 gm/km for 2000, with catalytic convertors the industry has been able to bring it down to 5.64 gm/km. Similarly, HC and NO_X has been brought down to 2.00 gm/km against the 1996 norm of 3.00 gm/km and 2000 norm of 0.97 gm/km.[1] Encouraged by these results, new norms are now being contemplated for metro areas as an intermediate measure before 2000.

Table 3.1.2 Progressive revision of emission standards for Indian vehicles (1991-2000)

Types of vehicles and pollutants	April 1991 standard	April 1996 standard	April 2000
Petrol vehicles: 2-wheelers			
CO (gm/km)	12-30	4.5	2.0
HC (gm/km)	8-12	–	–
HC + NO_X (gm/km)	–	3.6	1.5
Petrol vehicles: 3-wheelers			
CO (gm/km)	12-30	6.75	4.0
HC (gm/km)	8-12	–	–
HC + NO_X (gm/km)	–	5.40	1.5
Petrol vehicles: Cars			
CO (gm/km)	14.3-27.1	8.68-12.40	2.72
HC (gm/km)	2.0-2.9	–	–
HC + NO_X (gm/km)	–	3.00-4.36	0.97
Diesel vehicles*			
CO (gm/kwh)	14.0	11.2	4.5
HC (gm/kwh)	3.5	2.4	1.1
NO_X (gm/kwh)	18.0	14.4	8.0
PM (gm/kwh)	–	–	0.36
Diesel vehicles**			
CO (gm/kwh)	14.3-27.1	–	5.0-9.0
HC + NO_X (gm/kwh)	2.7-6.9	–	2.0-4.0

Notes: * : gross vehicle weight >3.5 tonnes
** : gross vehicle weight <3.5 tonnes
kwh : kilowatthour
gm/km : grammes per kilometre

SOURCE: 1

The automotive industry is unhappy with the fact that MEF has allowed the Petroleum Ministry to drag its feet for so long, while it was being hammered with conditions. "To meet the new emission norms, the automotive industry will have to invest Rs 50,000 crore in technology," says Doshi. "Unleaded petrol will only be a small fraction in the total petroleum bill. The government does not want to do its bit and spend some money on improving fuel quality." Eliminating lead from petrol and reducing the sulphur content of diesel, will address the specific problems of lead and particulate matter pollution, and facilitate the use of catalytic convertors. But there are several other shortcomings in fuel quality in India which interfere with efficient combustion, and foul up the engine.

Bad quality fuel leads to gum deposits on the engine which can clog up the carburettor passage and disturb the air-fuel ratio, thus leading to improper combustion. Vehicle manufacturers suggest that multi-functional additives be used in the fuel, in order to clean up the engine passages. They claim that if fuel causes clogged passages, then engineering modifications like recirculation of blowby gas or exhaust gas for complete burning and cleaner crankcase emission will compound the problem, as the recirculated exhaust gas will leave behind more deposits.

The automotive industry complains that vehicles are tested with reference fuel, specifications for which have been separately notified. This reference fuel, a superior oil used for standardisation of refinery fuels

Catalytic convertors run into rough weather

The wisdom in introducing catalytic convertors is under question

When the H B Mathur Committee recommended emission standards for 1996 and 2000, it also suggested possible technology upgradations for meeting them. The committee said that lead-free petrol and catalytic convertors were not necessary to meet the 1996 standards but would be needed for the proposed 2000 standards. At that time, the AIAM agreed and in a letter to CPCB, stated quite explicitly that the proposed standards for 1996 could be met with leaded petrol. "AIAM believes that both in the case of passenger cars and two- and three-wheelers, based on the industry's present technical capability and resources, the industry can work towards implementing the 1996 norms. For this it is anticipated that the industry will need to develop a new carburettor, piston, cylinder block, cylinder head and also, for some vehicles, modified engines."[1]

The letter supported the norms proposed by the S Raju sub-committee, which were more lenient than what was finally recommended by the Mathur committee but more stringent than the norms finally adopted by the MEF. While Raju had proposed mass CO emission standards at 6.2-11.1 gm/km and HC and NO_X at 2.7-4.6 gm/km with cold start measurement, MEF accepted CO emissions at 8.68-12.4 gm/km and HC and NO_X at 3.0-4.36 gm/km with warm start. The latter is more lenient because emissions are maximum during cold start.

But the industry changed its position soon after and demanded unleaded petrol as a precondition to the acceptance of the 1996 norms.[1] Its position was strengthened by a Supreme Court ruling in 1994, which made catalytic convertors mandatory for all new cars after April 1995.

Healthy conversion

Catalytic convertors, placed near the exhaust pipe in cars, chemically convert engine emissions into environmentally benign gases. The three-way convertors, used by the Indian automobile industry, promote reactions that oxidize HC and CO, converting them into water and carbon dioxide. A simultaneous reduction process removes diatomic oxygen molecules from NO_X during reactions with hydrogen, CO and HC producing nitrogen (N_2) and thus reducing NO_X emissions. The convertors use metals like platinum and palladium, with rhodium as a catalyst. Cars with catalytic convertors cannot use leaded gasoline since lead poisons the catalyst and renders the convertor ineffective.

The convertors work best with a chemically-correct mixture of air and fuel. HC and CO emissions are higher in a mixture which contains more fuel and less air, since part of the fuel remains unburned. NO_X, on the other hand, peaks in a lean mixture with more air for combustion. In a two-stroke engine, if the oil to fuel ratio is higher than 2 per cent, carbon and other residues block the catalyst cells and reduce the convertor's efficiency.

Although three-way catalytic convertors can reduce emissions appreciably, scientists of the Indian Institute of Petroleum (IIP) say that for optimum efficiency, a chemically correct mixture of air and fuel must be maintained throughout. This can be achieved only with the introduction of closed loop air-fuel ratio control systems, where the desired air-fuel ratio is maintained close to the stoichiometric (or chemically correct) ratio, with the help of a censor in the exhaust system, which monitors the oxygen concentration in the exhaust gas stream.[2]

None of the Indian manufacturers use this close loop system. Though the Mathur committee

proposed its introduction, it was treated as a premature suggestion. "We do not need a closed loop system for the 1996 norms," says Shivkumar, manager (engineering), Maruti Udyog Ltd. "We will introduce it only to meet the 2000 norms."

Unsuccessful attempt

Vehicles fitted with convertors have emission levels well below the recommended standards for 1996 but they are not exactly a runaway success with consumers. The erratic and inadequate supply of unleaded petrol needed for cars with convertors have driven several car owners to remove their convertors. "Vehicle owners get their convertors disconnected so that they can use leaded petrol," confirms a petrol pump mechanic at Green Park, Delhi. Others have found ways of dodging catalytic convertor fitted cars by buying and registering their cars outside the metros. R C Bhargava, chairman and managing director of Maruti Udyog Ltd, says that the sale of Maruti cars in Delhi has dropped by about 10 per cent since April 1995.

Taxi owners are particularly vocal about the inconvenience caused by convertors. "Almost all drivers complain about the erratic supply of unleaded petrol and an increase in the fuel consumption by at least 10 per cent," says S Quadros, general secretary of the Bombay Taximan's Association. If the supply of unleaded petrol is not stepped up, the scheme could backfire.

Officials in Bharat Petroleum Ltd (BPL) do not agree that unleaded gasoline supply is erratic and inadequate in Bombay. They claim that they are able to meet the demands of the city, which is increasing with the growing number of new emission controlled cars.

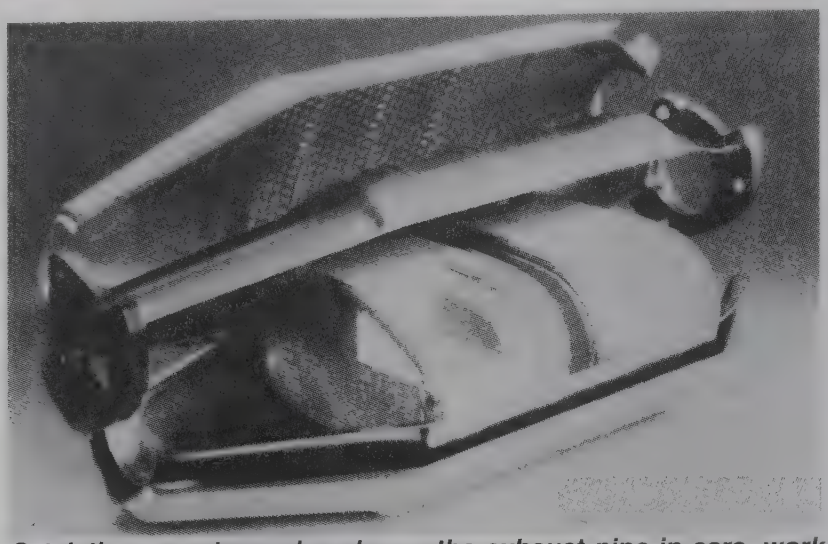
According to BPL projections, there will be 36,660 new cars with catalytic convertors in Bombay in 1995-96, and this will increase to 40,608 in 1996-97. Assuming that the average monthly consumption of a car is 45 litres, the demand for unleaded petrol will increase progressively from 11,232 kilolitres (kl) in 1995-96 to 12,441 kl in 1996-97. During this period, the requirement is likely to increase from 936 kl to 1,036 kl per month.[3]

Dubious efficacy

The efficacy of catalytic convertors is also being questioned for another reason. A convertor needs to be warmed up before it can function effectively. Little conversion takes place in the beginning, when the exhaust temperature is low, since the convertor is most effective between an exhaust temperature of 250 to 850 degrees centigrade (°C). The rate of chemical conversion increases rapidly only when the convertor reaches 250-300°C. So in effect, the convertor does not work when the engine is started and when emissions are maximum. Vehicles are not equipped to cope with cold start emissions. Slow moving traffic on Indian roads and frequent stoppages could also reduce its timing of effective operation.[4]

On the other hand, exhaust temperatures shoot up to 950°C in two-stroke engines and can damage the convertor and reduce its life expectancy. The proven life of convertors on roads so far has been about 7,000-8,000 km, though experimental convertors have registered a higher life expectancy of 15,000 km.[4]

The proposal to fit catalytic convertors in three-wheelers to meet 1996 standards has run into rough weather with autorickshaw unions in Bombay and Pune protesting against it. "We cannot simply afford to change catalysts every month," says Sharad Rao of the Bombay Labour Union. "We refuse to bear the additional financial burden. If this is enforced, the only beneficiaries will be the roadside constables, who will hike the *hafta* (illegal fine) rates."



Catalytic convertors, placed near the exhaust pipe in cars, work best with a chemically-correct mixture of air and fuel

across the country, is available only for testing purposes. "The fact that the engine runs much better on reference fuel only proves that fuel has a major role to play in controlling emissions," says Doshi.

The auto industry is particularly concerned because the proposed norms for the year 2000 require solutions like electronically controlled fuel injection systems, which need good quality fuel. Says B Ghosh of the Automotive Research Association of India (ARAI), "lead will have to be replaced with aromatics like benzene or oxygenates with high anti-knocking properties, to compensate for the loss in octane quality with removal of lead. These new components will have to be monitored carefully. Increase in oxygen content in fuel may decrease its calorific value and thus reduce the fuel economy of vehicles. And if petrol has a high aromatic fraction like benzene, the vaporisation rate will come down and impair the homogeneous air-fuel mixture." According to Ghosh, research has indicated that aromatic fuels quench faster, resulting in incomplete combustion. He apprehends that this may lead to engine seizure in two-stroke engines.

The automobile industry is demanding representation in the Bureau for Indian Standards (BIS) committee for fuel quality. "The auto industry wants to have a voice in matters related to fuel standards," says Doshi. "At present, the BIS committee is dominated by oil companies." Aromatics are a kind of hydrocarbon present in petrol or diesel and aromatic fraction refers to the proportion of aromatic hydrocarbon in fuel. The anti-knock property of fuel reduces/prevents the knocking tendencies (indicates that the combustion of fuel vapour is taking place too rapidly for efficiency) of the engine due to combustion.

The two-stroke dilemma

Except Hero Honda and Kawasaki Bajaj 100 cc motorcycles which have four-stroke engines (in which the cycle of suction, compression and combustion, expansion and exhaust, is completed in two revolutions of the crankshaft), all two- and three-wheeler models available in India have two-stroke petrol engines. India is the second largest producer of two-wheelers after Japan and has a disproportionately large two-stroke engine vehicle population. These two-stroke engines account for 65 per cent of the vehicle population in India and consume about 60 per cent of the petrol in the country.[4] They are largely to blame for polluting the ambient air quality in towns and cities and are responsible for as much as 70 and 48 per cent of the total HC and CO emissions, respectively.[1]

In the late 1980s, T N Seshan, then Environment Secretary in MEF, had recommended the phasing-out of two-stroke engines in view of the magnitude of the problem and the limited technological options available. But this did not evoke an enthusiastic response from his colleagues in the Ministry for Surface Transport and the Ministry of Industry.[5] It is difficult to gauge the impact of the recommendation since the industry and bureaucrats in the concerned ministries barely remember it. Even Rahul Bajaj, chairperson and managing director of Bajaj Auto Ltd (BAL), one of the largest producers of two-stroke engines in the country, denied any knowledge of such a proposition.

"Earlier, we did not have the necessary expertise or the experience to deal with the problem," says Bajaj. "Saying no to a technology is easy. But the two-stroke engine has its advantages and we cannot just throw it away. We are trying to improve it at the moment."

G K Sharma and N R Raje, scientists at the Indian Oil Corporation Research and Development Centre, Faridabad, point out that these engines have many advantages which the manufacturers want to retain. They are light, easy to manufacture, cost less, have a high specific output, an easy cold start and are easy to maintain. They also have lower pumping and friction losses which means for the same indicative power, the effective power is higher in two-stroke engines than four-stroke engines. "The chief advantage of two-stroke engines is that it provides twice the number of working strokes as compared to four-stroke engines at the same engine speed," says B Ghosh of ARAI, Pune.

The two-stroke engine is very high on HC emissions, as a large part of unburned fuel escapes with the exhaust. This problem is caused by the simple design of the engine which is otherwise advantageous. In a two-stroke engine, the air and fuel mixture enters the combustion chamber (the area in the engine where the combustion of the fuel-air mixture takes place) or crankcase (houses the crankshaft of an engine where oil from hot engine parts is collected and cooled before returning to the engine by a pump) through an opening which faces the exit point for the exhaust gases. Therefore, some of the fuel and air mix escapes unburned through the exhaust port with the burnt fuel. It has been estimated that between 20 to 40 per cent of fuel in two-stroke engines is lost in this manner.

"While it is true that HC concentration in the two-stroke exhaust is 7-10 times more than that in a four-stroke engine exhaust, it should be kept in mind that we are talking about a 150 cc two-stroke engine," adds Mathur. "In fact, the total amount of hydrocarbons which is coming out of a two-stroke 150 cc scooter engine is equal to the total amount of hydrocarbons from a four-stroke 1500 cc car engine. On the positive side, two-stroke engines emit only one-third to one-half of the nitrogen oxides that come out of a four-stroke engine."

India has a large two-stroke engine vehicle population — two-stroke engines account for 65 per cent of vehicle population in India, and are responsible for nearly 70 per cent of the total HC emissions and 48 per cent of CO emissions

The Indian automotive industry would prefer a more cost-effective, evolutionary change in technology, phased over a period of time. To develop the next generation of emission efficient two-wheelers, they are trying to modify the conventional two-stroke engine in stages. The current focus is entirely on modification of the design parameters of the two-stroke engine which affect the performance of the engine. The crankcase scavenge pump, port design and optimisation, combustion chamber, intake system (a system through which air and fuel are drawn into the engine), Reed valve, exhaust system, carburettor, ignition timing (refers to the time in crank degrees at which ignition is triggered), cylinder block, piston and piston ring are being focussed on. The fuel and emission efficiency are being improved by changing the design of some of these components.

The BAL design improvement programme for the two-stroke engine includes the introduction of a third transfer port and a change in entry design of the ports, to avoid a mix-up of fresh fuel and air with exhaust gases. Also, the shape of the cylinder head will be changed from wedge-shaped to semi-spherical and there will be an improvement in the combustion ratio from 7:8 to 9:10. BAL also plans to introduce narrow jets to ensure a leaner flow of fuel into the engine, introduce bigger ventury sizes (which regulate pressure points) to allow more air in and improve the air fuel ratio, and change silencers to regulate the

wave of exhaust gases.

BAL research and development (R&D) scientists claim that it has taken more than a year to change the engine design in each model. With these improvements, BAL will bring down the CO mass emission level from 6-7 gm/km to 4.5 gm/km, and HC emission from 5-6 gm/km to 3.6 gm/km in the approved two-stroke two-wheeler prototype. When this goes into mass production, allowing for a 20 per cent relaxation under the Conformity of Production test (COP), CO will measure 5.4 gm/km and HC 4.32 gm/km, with some amount of variation across the models. On the road, CO will be 4.5 per cent of the total exhausts by volumetric measurement at idling.

But BAL will run into trouble when it will decide technology options keeping in view two different consumer segments — one demanding greater fuel economy and the other more power. To balance the two and still keep emissions low, requires more sophisticated technical solutions. With a leaner air-fuel ratio (that is, less fuel and more air), BAL two-wheelers get better fuel economy, but not enough power. In a rich mixture, on the other hand, they get more power but also more emissions. Unlike the four-stroke Bajaj Kawasaki 4 Champion, which has a leaner air-fuel ratio but a reduced horse power of 7, the 11 horsepower Bajaj Kawasaki RD2 will not meet the 1996 norms.

Commenting on this, Madhur Bajaj, BAL president, says, "the performance of high-powered models are oriented towards good speed and high acceleration. Any engine modification to achieve desired emission levels, will have to be done without compromising on these qualities to protect its market."

But experts doubt that evolutionary changes in the existing carburettor model of two-strokes can meet the more stringent norms of 2000 and feel that more radical changes, like fuel injection systems, would be needed to cope with the problem. BAL agrees that while optimisation of the conventional engine design will help it to meet the 1996 norms and can be improved by another 5 to 10 per cent subsequently, it will not meet the 2000 norms. "As emission regulations become more stringent, even the stratified charging of fuel, which is one of the most advanced technique that can be adopted to the conventional design, will not help since fresh fuel will still be lost during scavenging," explains Ghosh.

Scientists say that the most logical approach to prevent complete loss of fresh fuel charge to exhausts is to scavenge the cylinder with pure air and introduce fuel after exhaust port is closed. This suggestion has occupied the attention of the engineers for sometime now. But the key to the success of this possibility lies in the development of a high performance injection system, capable of getting the fuel into the cylinder in something like one-fifth of the cycle time (which could be as little as 2 milliseconds). This puts a severe demand on the fuel injection system to provide precise fuel metering, fine atomisation and good fuel distribution.

The two-wheeler industry and ARAI scientists claim that though a number of experiments are being conducted the world over to develop a two-stroke engine with a fuel injection system, none of them are commercially

Table 3.1.3 Emission norms for two-stroke two-wheelers in different countries

Country	CO (gm/km)	HC (gm/km)
USA (for all capacities)	12.0	5.0
Sweden (more than 50 cc)	8.0	3.0
Taiwan (150 cc)	4.5	3.0
Austria (more than 50 cc)	8.0	7.5
Switzerland (more than 50 cc)	8.0	3.0
Germany (more than 50 cc)	12.8	8.0
India (proposed for 2000)	2.0	1.5

Notes: CO : carbon monoxide HC : hydrocarbons
gm/km : grammes per kilometre

SOURCE: 1

viable. "The whole world is groping for solutions to two-stroke engines," says Rahul Bajaj. "If I come across a cost-effective and technically viable solution I will snap it up immediately." The current norms set for emissions from two-stroke two-wheelers in different countries are given in Table 3.1.3.

Technology transfer: bleak prospect

Since even global giants manufacturing two-wheelers, like Piaggio Co in Italy and the Orbital Engine Company in Australia, have not been able to develop commercially viable fuel injection system for two-wheelers, the prospect of technology transfer in this area seems bleak. Scientists at the Automotive Research Association of India (ARAI) point out that only Orbital Engine Company has come up with a fully developed process while others are still in the experimental stage. And the technology developed by Orbital, an electronically controlled low pressure injector developed for marine outboard application, is very complex and too expensive for two-wheeler engine application.

The reason for the low technological advancement in this field the world over is the fact that the share of two-stroke vehicles in developed countries is low. According to Indian Oil Corporation Limited (IOCL) estimates, *two-stroke vehicles in developed countries consume only about 2 per cent of all available petrol, whereas in India the figure is as high as 60 per cent of the total petrol consumption.* In Europe, two-stroke motorcycles are used in sports and cross-country riding, making high-powered engines a necessity. As a result, emission norms for two-wheelers in both US and Europe are lax.

At present, Taiwan has the strictest norms for two-wheelers at 3.5 gm of CO emission per km and 2 gm of HC per km. India's proposed norms for the year 2000 (CO 2 gm/km and HC 1.5 gm/km) are more stringent than this.

The Orbital Engine Company is working on the possibility of using the improved two-stroke engine even in passenger cars. According to H B Mathur, both Ford and General Motors in the US are appraising the Orbital engine and may even develop one of their own. BAL has joined hands with Orbital but has yet to come up with a proven, viable and cost-effective design for two-wheelers.

BAL also has another constraint on technology transfer. Having cornered about 50 per cent of the two-wheeler market in India, which is the largest in the world, it cannot enter into technological collaboration with international competitors like Yamaha and Honda who are also trying to gain a foothold in the Indian market. "We have a bigger market than most of our competitors," says Madhur Bajaj. "In such a situation, joint ventures and tie-ups become difficult. So we can only look towards international research and development (R&D) institutions like Orbital for technical know-how and rely on our own R&D as much as possible."

Ironically, BAL has a market in several Asian countries and exports have gone up from 6,684 units in 1991-92 to 31,079 in 1993-94. "Emission norms in most importing countries are still very lax," says Madhur Bajaj. "In fact, we can use improved emission performance as a marketing point in exports. Only Thailand has some restrictions with the government insisting on CNG technology for their commonly used three-wheelers called *tuktuks.*"

Problems facing three-wheelers

About 92.5 per cent of the two-stroke two-wheelers will survive the standards set for 1996. However, according to AIAM experts, unless the government concedes to the demands of the three-wheeler manufacturers, two-stroke three-wheeler manufacturers will have no option but to stop manufacturing.

According to the 1996 standards, three-wheelers will have to restrict themselves to a CO emission level of 6.75 gm/km and a HC emission level of 5.4 gm/km. But as N V Iyer, R&D manager at BAL explains, the weight and power ratio in three-wheelers poses a problem. Three-wheelers have engines

ARVIND YADAV / CSE

Three-wheelers have engines identical to two-wheelers but carry a heavier load. As a result, they consume more fuel for the same level of efficiency and thus emit more exhaust

identical to two-wheelers, but they carry a heavier load. As a result, they consume more fuel for the same level of efficiency and thus emit more exhaust.

The industry had offered a few options as a way out of this impasse but none was particularly satisfactory. BAL suggested that either the HC emission norms be revised to 7.2 gm/km as against the proposed norm of 5.4 gm/km and that manufacturers get a two-year grace period to come up with a new four-stroke engine; or they be allowed to use catalytic convertors without changing the engine design till they switch over to four-stroke engines for three-wheelers. They contended that 7.2 gm/km would be a considerable improvement upon the current level of 8 to 9 gm/km.[6]

The proposal to fit catalytic convertors to the modified two-stroke engine can limit the emission level but it is not a cost-effective option. According to Rajat Nandi, executive director, AIAM, the world-wide experience in using catalytic convertors for two-stroke three-wheelers is limited. "Though designs for catalytic convertors are available with a 15,000 km life expectancy, the proven life expectancy on roads is not more than 5,000 to 6,000 km," says Nandi. "In Delhi, where the average mileage of three-wheelers is 100 km a day, the convertors will have a very short life span and replacing them again and again will be expensive."

The other option of developing a two-stroke engine with a fuel injection system is still not technically and commercially viable, while switching to four-stroke engines will take the industry another two years.

The government, meanwhile, is insisting on a design improvement in the engine to meet the original norms with leaded petrol, much to the ire of the industry. "The government cannot dictate a technology route to us," says Rahul Bajaj. "*The business of the government ends with setting of norms and its implementation. If the government does not agree, I am not going to beg. I will simply stop producing three-wheelers.*"

While BAL suggested that they be allowed to you catalytic convertors, the government did not budge

from its stand and insisted on engine modifications. Finally, BAL agreed to it but said it needed time.

According to N V Iyer, building a prototype is one thing but BAL was apprehensive about going in for mass production as there may be a variance. A prototype of the modified engine was made and it was followed with a conformity of production (COP) test which is necessary for mass production. On receiving the official approval certificate for the prototype, BAL has gone into mass production by tightening up, what is called in technical parlance, the manufacturing variance.

But this problem with three-wheelers took another twist recently. Although the industry has resorted to engine modification, lawyer and environmental activist M C Mehta has filed a case in the Supreme Court for catalytic convertors to be included in three-wheelers. The industry claims that it has met the 1996 norms and it is now gearing up to meet the 2000 AD norms by exploring all options. Catalytic convertor are in any case an intermediate solution for which unleaded petrol is a necessity. According to N V Iyer, fitting catalytic convertors is only one of the solutions and since the 1996 norms have been met without catalytic convertors as insisted by the government, there is no need for catalytic convertors to be forced upon the manufacturers.

Passenger car sector

The passenger car industry in India has cause for serious concern. Several of the successful market products like Maruti Udyog Limited's (MUL) Gypsy, Mahindra & Mahindra's (M&M) jeeps, and Hindustan Motor's petrol-run Ambassador car will have to go off the market because these cannot meet the 1996 norms. In desperation, MUL and Mahindra & Mahindra had even pleaded that cross-country vehicles should be excluded from the norms, as done in Europe. But this proposal was turned down by former Environment Minister Kamal Nath on the grounds that these vehicles are not used solely for cross-country transport in India but are an integral part of city transport, and thus contribute to city pollution.

The 1996 standards have fixed norms for evaporative, crankcase and exhaust emissions from cars. Crankcase emissions, constituting gases and vapours which escape under pressure from the combustion chamber, are discharged into the atmosphere through the crankcase and contribute to about 20 per cent of the total HC emissions. The 1996 norms have stipulated that crankcase emissions should be reduced to zero. This does not present a problem to the industry since many of them, including the Maruti, Contessa and NE 118 models are already equipped with Positive Crankcase Ventilation (PCV) systems which assist in recycling the gases for complete combustion. Such is not the case with Maruti Udyog's Gypsy, Mahindra & Mahindra jeeps and petrol run Ambassador cars.

Evaporative emissions, on the other hand, present a problem for all Indian petrol-run cars. The major source of evaporative emissions are the carburettor bowl (the part of the carburettor which contains the fuel) and the fuel tank. HC vapours escape from the fuel tank while fueling, and from the carburettor during the hot soak period. Evaporative emission testing facilities are available only with MUL in India, while control devices are not produced at all. The automobile industry has asked for a delay in adopting the evaporative emission norms on these grounds but the MEF has refused so far, directing it to get vehicles tested wherever such facilities are available.

The passenger car industry is also concerned about the indicative norms for 2000 and is already lobbying hard to dilute the norms. It has asked for changes in the testing methods for emission inspection, replacement of the Indian driving cycle (driving cycle that simulates average road driving conditions such as acceleration, cruising, deceleration, etc) with the European, and postponing the adoption of cold start.

It has already once successfully postponed the enforcement of cold start emission testing, originally scheduled to come into force in 1996, to 1998, by pleading inability to adopt the appropriate technology. "We need time to develop the sophisticated technology needed to reduce the emission level during cold

starting the engine but the government wants us to achieve a 5 gm/km CO emission level with cold start by 1998," rues S J Shah, former executive director of Automobile Association of India. Auto manufacturers contend that since they will have to overhaul their technology by 2000 in any case, to meet more stringent norms, an isolated intermediate change in 1998 is unnecessary.

The car industry has also found a scapegoat in the emission-testing procedure currently prevalent in India. "Our system of testing makes Indian norms more stringent than in the US and Europe," says Shah. India follows the conformity of production (COP) test procedure like other countries where a prototype vehicle is approved by the testing agency and the mass scale production of the vehicle is expected to remain consistent with the approved prototype. But vehicles are picked up at random from the assembly line in the Indian version of COP, in contrast to the averaging system followed in the US.

Under the averaging system, a log is maintained on vehicles produced every day and an average is taken of the last six months' emission data, to ensure that it does not cross the prescribed limit. The vehicles can remain within a close range of the prescribed limit, with the average taking care of small variations. "Under the Indian system, even the worst vehicle on the production line will have to be within the prescribed limit or both the owner and the manufacturer of the vehicle will be prosecuted," says Shah. "But the averaging system makes the system more flexible. In case the owner of a vehicle is prosecuted, he can get a certificate of exemption from the manufacturer."

The Indian system creates more pressure as well because along with remaining within the prescribed limit, Indian companies also have to stay much below the norm to allow for 30 per cent variation during mass production. "This means we are actually producing vehicles with emission levels 50 to 60 per cent below the mass emission norms so that each and every vehicle can remain within the limit."

Auto manufacturers are resentful, as any technological advancement they make to reduce emissions, creates a trap for them. Against the current mass emission norms for CO at 14 gm/km, for example, industry has achieved 7 gm/km under the prevalent testing procedure. So when the Mathur committee was finalising norms for 1995 and 2000, manufacturers contended that if industry had already achieved 7 gm/km against the prescribed limit of 14 gm/km, it should be able to bring emission levels down to 3 gm/km in the future, under the proposed norm.

The passenger car industry fears that if the averaging system for testing is not allowed under the new norms, it will find itself technically ill-equipped to keep emissions 50 to 60 per cent lower than an already low limit of 3 gm/km.

But as industry and government juggle numbers, pollution control is reduced to a statistical game and any formulation which promises to show better emission results is welcome, regardless of its actual impact on air quality. The current controversy between the European and the Indian driving cycles is an example. The driving cycle is a statistical formulation arrived at by simulating road conditions which the vehicle is likely to traverse on a chassis dynamometer (a device which facilitates engine testing under the conditions simulating certain situations of road operation of the vehicle). It serves as a reference model for testing vehicles. In India, this is a 12 to 14 mode cycle, with each mode depicting periods of acceleration, deceleration and idling in certain time intervals. The emission level for each mode is measured and then an average is taken to arrive at a mass emission level.

The Indian driving cycle has been developed by the Automotive Research Association of India (ARAI) on the basis of vehicular data collected in select cities. Data was collected on average speed, cruising at normal speed, deceleration and acceleration, time of idling, stoppages and so on. Due to prevailing road conditions in India, the driving cycle shows frequent and sharp acceleration and deceleration curves and a long idling time. This increases the emission level during a cycle considerably since vehicle emissions increase during acceleration and idling. Any technological change would have to measure up

RUSTAM VANIA / CSE

to standards against this cycle. The European driving cycle, on the other hand, is based on much better road conditions and shows gentler acceleration and deceleration curves.

"No two cities in India are alike and, therefore, even the Indian driving cycle is not truly representative," says Vinod L Doshi, chairperson and managing director of Premier Automobiles Ltd. "We use driving cycles only as a reference model to test our vehicles. It will not matter if we adopt the European driving cycle." Doshi claims Indian vehicles tested on the European driving cycle show improved performance and emissions.

Scientists at the Indian Institute of Petroleum (IIP) argue on behalf of the European driving cycle by saying that emissions are lower by about 20 per cent in the Indian cycle on a warm start engine than in the European cycle run on cold start. They do not comment on how the vehicles would perform in the Indian driving cycle on a cold start.

The passenger car industry is also concerned about the indicative norms for year 2000 and is already lobbying hard to dilute the norms

The automotive industry has a larger vested interest in adopting the European cycle. The new emission standards have made technology transfer and tie-ups necessary and most of this technology is designed according to the European driving cycle. So manufacturers find it expedient to adopt that cycle. S Sankara Narayanan, president (operations), Hindustan Motors Ltd, puts it bluntly, "if the European driving cycle is adopted we will not have to do any development work here since someone else has already done the job abroad." Industry representatives admit that neither do they have the technical know-how to modify the imported technology to suit the Indian driving cycle, nor would the supplier find it worthwhile to undertake design modifications for a small market like India.

The government's position on this issue has been inconsistent from the beginning. The industry started demanding the European driving cycle in 1985, when Maruti's entry into the market brightened prospects of importing technology but the government had turned down the proposal. But ever since

emission norms came into the picture in 1991, industry has become more vocal in its demand and official sources indicate that the government may actually give in. Officials in both MEF and CPCB seem to agree with the contention that the Indian driving cycle is not representative of the whole country and, therefore, there is no harm in adopting the European driving cycle. But CPCB chairman D K Biswas puts in a word of caution: "Even if we adopt the European driving cycle, we must insist on a corrective factor to suit the Indian driving and traffic pattern so that the manufacturers can develop a safety factor for engine designs."

But H B Mathur is dead against the shift. "It is absolutely illogical that they should now reject the driving cycle developed by one of their own agencies as irrelevant," he says. "We cannot copy driving cycles from others. Our cycle is representative of our road conditions. If the European driving cycle is adopted, vehicles will continue polluting, though the paper will show differently."

Diesel-powered vehicles

To veer around the constraints on two-stroke petrol engines, some of the two-wheeler manufacturers are opting for diesel-powered engines for some of their products. Crompton & Greaves is already marketing a diesel three-wheeler named 'Gaduda' in Pune. BAL has also developed a model which it plans to launch soon. While these diesel vehicles would cut down CO and HC emissions, NO_X and SPM emissions will increase. The catch, however, is that no emission norms have been set for three-wheeler diesel engines.

This escape route has caused some concern among the experts. "When diesel Ambassadors were introduced for the first time, we brought it to the notice of the MEF and Petroleum Ministry that in a country like India, where diesel has other uses in the agriculture, power and marine sectors, it does not make economic sense to divert it for luxury consumption," says Mathur. "The Petroleum Ministry had

ARVIND YADAV / CSE

In a country like India, where diesel has other uses in the agriculture, power and marine sectors, it does not make economic sense to divert it for luxury consumption

Table 3.1.4 1991 emission standards for diesel vehicles in India

Method of test	Maximum smoke density		
	Light absorption coefficient	Bosch units	Hartridge units
Full load at a speed of 60 to 70 per cent of maximum engine rated speed declared by the manufacturer	3.1	5.2	75
Free acceleration	2.3	65	

SOURCE: 8

proposed to ban it then but didn't do so. Today everybody, including Maruti Udyog, wants to switch over to diesel because it is cheaper than petrol."

The production figures of Hindustan Motors Ltd are indicative of this trend. Petrol vehicles do not feature in their future plans at all. Of 27,000 Ambassador cars produced by the company, 2,300 or 15 per cent are diesel vehicles. Hindustan Motors Ltd's new model, Isuzu 2000 D, which is to be marketed shortly, also has diesel engines. "Our future plans are based on diesel and compressed natural gas (CNG)," says Narayanan. The standards for emissions of diesel-powered vehicles in India is shown in Table 3.1.4.

Research and development

Investment in research and development (R&D) in the automobile industry has so far supported evolutionary and incremental changes in technology. According to AIAM estimates, the industry's average spending on R&D is 1.1 per cent of the turnover, amounting to Rs 181.7 crore. Among the two- and three-wheeler manufacturers, Kinetic Engineering spends 2.2 per cent of its turnover; Kinetic Honda Motors, 2.1 per cent; Majestic Auto, 1.7 per cent; Hero Honda Motors, 1.2 per cent; and BAL, 1.0 per cent. Among the passenger car manufacturers, the average spending is 0.5 per cent, with MUL rating the highest at 0.6 per cent. Investment in R&D is highest in the commercial vehicle sector, with an average of about 2 per cent. TELCO leads with 2.5 per cent, followed by Bajaj Tempo at 2.1 per cent.[9]

While admitting that the auto industry's narrow outlook is largely responsible for the low R&D expenditure, Doshi also blames the government for not utilising the finance mobilised through R&D cess. "In the last 12 years, the government has collected Rs 114 crore as R&D cess from the industry, all of which has gone to the consolidated fund of India. Rs 81 crore of this has remained unspent and the backlog of approved R&D projects is piling up."

Industry watchers predict that R&D issues related to indigenisation and local capacity building are going to change with the global restructuring of the automobile industry. The future plans of most of the companies are based on tie-ups with foreign companies, which are poised to enter the expanding Indian automobile market. The market for cars in India has increased at the rate of 16.8 per cent per annum during the 1980s, as compared to 3.6 per cent during the 1970s. In 1993, car sales have increased by 21.6 per cent and are expected to increase at a much faster rate in the next decade.

Joint ventures and technical collaborations have already taken root in the country and some of the global players in the passenger car sector are sending component kits to other countries for assembly. Italy-based Fiat is signing agreements for fully assembling CKD (Completely Knocked Down) kits for their 178 World Car with partners in six countries, including Premier Automobiles Limited (PAL) in India. If this comes through, PAL will start producing 50,000 cars per annum. About US $50 million (Rs 175 crore) will be invested in this project. PAL's total R&D investment of Rs 196 lakh is a pittance in comparison.

3.2 **Poor quality fuel**

THE days of state monopoly in India's oil and natural gas sector could be numbered if liberalisation is still the buzzword after the 1996 general elections. Addressing an industry conference in New Delhi, on September 24, 1995, oil and natural gas secretary V L Kelkar, outlined a reform programme aimed at redesigning incentive structures, promoting competitive markets, creating regulatory frameworks and restructuring state-owned companies, to make them more effective.

Kelkar noted that the present state of affairs within the hydrocarbon (HC) sector had created an incentive structure which is not conducive to promoting efficiency. He was probably referring to the capacity of Indian refineries to meet expanding needs, but his statement also has a direct bearing on the environment. *Inefficient refining processes means bad quality fuel, which in turn means increased vehicular emissions.*

Fuel quality was hardly ever considered responsible for vehicular pollution in Indian cities until recently. The petroleum sector pointed a convenient finger at the automobile industry every time the subject came up. But the contribution of bad quality gasoline and diesel to air pollution in India has been grudgingly acknowledged over the last few years.

"I would say that 50 per cent of the problem of vehicular emissions is due to bad engine design, 20 per cent due to maintenance and bad road conditions, and 30 per cent of the problem is caused by bad fuel quality," estimates B Sengupta, head of the Pollution Control Implementation Division of the Central Pollution Control Board (CPCB), though no actual study has been conducted so far.

Gasoline contributes most of the carbon monoxide (CO), unburned HC which include certain compounds that are carcinogenic, and lead to vehicular pollution, while the main pollutants from diesel vehicle emissions are suspended particulate matter (SPM), sulphur dioxide (SO_2) and nitrogen oxides (NO_x).

The causes for poor quality fuel are deep-rooted; they begin at the policy-making level and filter down all the way to the customer, with outdated technology at refineries and corrupt petrol dealers compounding the problem.

Standards governing fuel quality

At the policy-making level, many consider that the primary flaw lies in the fact that the very agency that manufactures fuel, is responsible for setting standards for its quality. The Indian petroleum industry is, so far, dominated by public sector companies such as Indian Oil Corporation Ltd (IOCL), Hindustan Petroleum Corporation Ltd (HPCL) and Bharat Petroleum Corporation Ltd (BPCL). The fuel from these refineries is expected to follow specifications from the Bureau of Indian Standards (BIS), which are set by the Committee for Formulation of Fuel Quality Specifications. This committee consists of members from the Ministry of Petroleum and Natural Gas, BIS, the Automobile Association of India, the automobile industry, the Ministry of Industry, the CPCB, and research organisations like the Centre for High Technology. Ironically enough, the committee is headed by an advisor to the Petroleum Ministry.

It is not surprising then that the Ministry of Petroleum and the public sector refining industry usually have the last word in these meetings, by simply saying that their refineries do not have the technology to meet better standards, and upgrading the technology would be too expensive. A few changes have finally been accepted by the committee at the meeting held in April 1995, but they have not been implemented so far. The BIS has published the new specifications, but BIS officials have not notified the

Lax fuel standards have allowed Indian refineries to get away without improvements for years—what could have been done in a phased manner over the years, now has to be achieved over a short period

refineries. "They have yet to send us a copy, though we are on the fuel quality committee," said S K Jain of the Centre for High Technology. "The date of implementation on the publications has been put down as July 1995, but it is a case of the government issuing standards to the government, so they'll take their time over it. Besides, the standards are voluntary, so who's checking?"

This is the other loophole the BIS standards offer to the refineries — their standards are compulsory only in the case of 140 industries, and the petroleum industry is not one of them. "The enforcement of these standards is up to the Ministry of Petroleum and the refineries themselves," says a BIS official.

But for the last two years, a fuel committee set up by the Ministry of Environment and Forests has been trying to notify a more binding set of standards under the EPA. This committee, headed by CPCB chairperson, D K Biswas, included K P Shahi from the Ministry of Petroleum and Natural Gas, D K Chaudhary from BIS, B P Pundir from the Indian Institute of Petroleum (IIP), N Bagchi from the Environment Ministry, A N Prasad from the Centre for High Technology, the executive director of the Petroleum Conservation Research Association, and B Sengupta from CPCB. Two years of haggling finally led to a consensus, and the committee agreed on a set of standards during a meeting held in August 1995. But since then, both the Petroleum and Environment Ministries have resorted to file-pushing as a delaying tactic, and it seems unlikely that the standards will be notified soon.

"So long as the regulator is the owner of the company, there is little scope for improvement in the quality of the product," points out Vineet Nayyar, who has worked on a World Bank project for improving transport systems in Bangkok and is former chairperson of the Gas Authority of India Ltd. According to him, the project found that 55 per cent of the problem of vehicular pollution in Bangkok was due to poor

quality fuel. But there was a marked improvement in fuel quality after refineries were privatised in 1991 and the role of the government was restricted to quality control.

The complete inefficiency in implementing the present standards was made apparent in an exercise conducted by Centre for Science and Environment (CSE). In an attempt to discover just how bad the fuel retailed in India was, CSE requested the Indian Institute of Petroleum (part of the Council of Scientific and Industrial Research) at Dehradun, to test a few fuel samples. They politely but firmly declined, saying that it would cause them too much trouble. Written requests simply went unanswered. The other research laboratory with requisite equipment, the Indian Oil Corporation Limited Research and Development Centre, was also unwilling.

CSE finally located a private lab where some basic parameters responsible for pollution could be tested. V B Arora, Chief Executive of AES Testing and Research Laboratories, however, suggested that such an exercise would be futile. The BIS standards were so lax, he said, that it was unlikely that any fuel would fail.

Since Indian refineries have been allowed to get away with anything for so long, fuel specifications which take environmental parameters into account constitute a very new concept, and we are far behind the world standards (see Table 3.2.1). "Norms set for the petroleum industry until very recently were quality measures for performance, not pollution," admits A P Chaudhri, a senior representative of the Centre for High Technology of the Indian Oil Corporation.

On the other hand, countries like the US and Germany have been upgrading their fuel quality over the years with the environment in mind, and they now adhere to stringent quality control norms. The Clean Air Act of the US, which focussed attention on controlling emissions, came into effect in 1980, and unleaded gasoline was introduced a decade ago. Diesel quality the world over has been improved considerably, with sulphur content in the fuel used in some of the European countries as little as 0.2 per cent.

Table 3.2.1 **Comparison of Indian and European fuel quality standards**

Characteristics	India	Western Europe
Gasoline		
RON	87	89-94
MON	Not specified	80-84
Benzene (v%)	Not specified	3-5
Aromatics (v%)	Not specified	30-50
Sulphur (ppm)	2000	300-500
Diesel oil		
Sulphur (% weight)	1.0	0.2-0.5
Cetane number	42	45-50
Aromatics (v%)	Not specified	25-35

Notes: RON : Research Octane Number
MON : Motor Octane Number
ppm : parts per million
v% : per cent by volume
% weight : per cent by weight

SOURCE: 10

Many countries are now moving towards 'reformulated fuels' with a view to cutting down further on emissions. As the name suggests, these fuels will be formulated to eliminate the root causes of vehicular emissions. In the US, the Clean Air Act Amendment (CAAA) of October 1990[1], set standards for reformulated gasoline (RFG) after carefully monitoring pollution levels in urban areas.

In India, unleaded gasoline was introduced in four major metropolitan cities only in April 1995 (and will be available in the rest of the country only by 2000 AD), and the sulphur content of diesel is still as high as 1 per cent by weight — 2 to 5 times higher than in any other country.

But what is worse, perhaps, is that

The refining process

Indian refineries implement outdated processes to produce fuel

Gasoline and diesel are products of rock or crude oil, which is a complex mixture of hydrocarbons (HC) along with oxygen, nitrogen and sulphur compounds. Normally, three types of HC are present in crude oil — paraffins, napthenes and aromatics. While benzene is the chief aromatic present, the paraffins series is the broadest, extending from methane, which forms natural gas, through the liquids refined into ordinary gasoline, to crystalline waxes. The napthene series ranges from volatile liquids to tarry asphalts. Olefins or unsaturated straight chain hydrocarbons are not a constituent of crude oil, but come up from the decomposition or cracking of other hydrocarbons, when they are subjected to high temperatures during refining.

Most crude oils contain small amounts of hydrogen sulphide; this increases with the breakdown of heavier sulphur compounds during distillation. Though most of the hydrogen sulphide evaporates in overhead gases, some remains dissolved in the final product.

The various HC compounds that are mixed together in crude oil have different boiling points. During the refining process, crude oil is fractionally distilled into fractions producing different petroleum products. The typical boiling ranges are: motor gasoline 25°-150° C, kerosene 150°-230°C, diesel oils 230°-340°C, and fuel oils above 340°C.

Distillation controls the volatility characteristics of petroleum products and needs to be controlled for optimum performance in their intended application. But in order to maximise production, Indian refineries take wider cuts of high demand petroleum products, thus affecting performance. "This practice results in an increase in the sulphur and carbon content in the fuel, which in turn causes vehicular exhaust containing particulates, smoke and sulphur dioxide," points out chairperson of the Central Pollution Control Board, D K Biswas.

Petroleum products, in the order in which they are distilled from crude, and their uses:

Light distillates:

1. Fuel gas, used as fuel in the refineries itself
2. LPG, used as a domestic fuel
3. Naptha, used in fertiliser and petrochemical industries
4. Gasoline, used by spark ignition engines

Middle distillates:

5. Aviation turbine fuel, used in aircraft
6. Superior kerosene oil, used as a domestic fuel
7. High speed diesel (HSD), used in compression ignition engines

Heavy distillates:

8. Fuel oil, used in furnaces and boilers
9. Bitumen, used for road paving
10. Lubricating oils, used for engines and machines
11. Speciality products like waxes, solvents, transformer oil, white oils and paraffins

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The 'green' unleaded petrol supplied by our refineries is far from safe as they are high on carcinogenic benzene emissions

even some recent measures have been implemented without keeping the entire scope of the problem in mind, and could send us straight out of the frying pan and into the fire. The so-called 'green' unleaded petrol our refineries are supplying is far from safe. Reducing lead in petrol involves the addition of several other compounds which increase carcinogenic benzene emissions. But India has absolutely no standards for 'air toxins' like benzene, olefins and other aromatics, which is why our refineries are able to supply the unleaded fuel without upgrading their technology. So far, only a tentative 5.0 per cent by volume (v%) limit on benzene content in gasoline has been proposed for the year 2000.[2] In the US, Germany and other countries, benzene in motor gasoline has been restricted to 1.0 v% for several years now.[1]

The lack of any control on benzene content of fuel allows Indian refineries to have a higher vapour pressure rating for their fuel which results in more benzene emissions and the formation of ground level ozone. The Reid vapour pressure (Rvp) for gasoline in India is 0.7 bar, compared to 0.5 bar in the US, which is considered very high for a tropical country like India, with its faster evaporation rates.[1] The fallout of this rating is unknown since nobody has measured ground-level ozone in India yet.

Several hundred crore of rupees have already been spent on providing lead-free petrol to India's metros, though the benefits of such a move are negated by the government's piecemeal and gimmicky approach to the problem. Instead of resorting to half-baked schemes like the introduction of unleaded fuel without studying the possible effects of increased benzene content, a comprehensive solution to process better quality fuel would pay better dividends.

Bureaucrats rule, OK

Ministry refuses to take up the opportunity to defend itself

If India's public sector refineries are being accused of producing poor quality fuel, then fuel available in petrol bunks should be tested, and the Petroleum Ministry must be given a chance to defend itself.

For the fuel test, the Centre for Science and Environment (CSE) contacted the Indian Institute of Petroleum (IIP), Dehradun — one of the few institutions in India, we were told, with the requisite equipment to test pollution related parameters. We were, of course, willing to pay for the test. But the institute refused because of a previous incident where testing the fuel for a private party resulted in a tedious court case. Thereafter, written requests went unanswered by the Institute.

When the Indian Oil Corporation Research and Development (R&D) Centre in Faridabad also refused, we traced down a private laboratory in Delhi, AES Testing and Research Laboratories, which could test the fuel samples. But according to chief executive of AES, V B Arora, testing the fuel would be futile. "Most of the fuel will definitely meet the Bureau for Indian Standards (BIS) standards," he said. "The point is, the BIS standards are so lax that the fact that the fuel does not meet the standards is of no consequence — the fuel is still of poor quality."

To get the viewpoint of the Petroleum Ministry, we tried to get in touch with the secretary, Vijay Kelkar, who had stated at a conference in Delhi that the current structure of the hydrocarbon sector provides no incentives for efficiency. At first, it seemed as if he was a genuinely busy man, as call after call went without so much as an acknowledgement. After not being able to contact him for more than three months, we sent him a fax, pointing out that three months was a long time to wait for an interview, but if he could specify a date, no matter when or where, we would very much like to include an interview with him as part of this study. Again, there was not even an acknowledgement. Kelkar's secretary told us that the fax, which outlined the questions we wanted to ask Kelkar, had been sent to the undersecretary, and would take a long time.

After months of trying to contact him, we finally managed to speak to him at home one day. He flatly refused to give us an interview. "Not this time — speak to somebody else in the ministry," he said.

Was Mr Kelkar afraid? Or is his office so disorganised that he could not even pass on a message through one of his personal assistants, to save us the bother of calling again and again? This is just another example of the level of unaccountability, if not evasion, amongst the bureaucracy. The very least it can do is acknowledge a request for an interview, even if it is to say that it does not have the time to answer for its department's inefficiency to the press.Quite different from the response we received from industrialist Rahul Bajaj.

Fuel from Indian refineries

"During the next three to four years, Indian refineries will have to make an investment of more than Rs 5,000 crore (about US $1,600 million) towards improving the quality of gasoline and diesel to meet stringent specifications," says A P Chaudhri, executive director of the Centre for High Technology.

Lax fuel standards have allowed refineries to get away without any sort of improvements for years. What could have been done in a phased manner over the years, as in Europe and the US, now has to be achieved over a short period. Officials from the industry claim that there has been no incentive for investing in better equipment so far. "Why should we invest in better technology so long as the rates of petroleum products remain regulated?" asks a senior official from IOCL.

Newspaper reports have alleged that the private refineries slated to come up in the next few years, including Mangalore Refineries and Petrochemicals (MRPL), Reliance Petroleum and Essar Oil, propose to use old refining equipment which has been lying idle abroad for as long as 40 years and, therefore, cannot be expected to improve on the existing situation, though more stringent standards are proposed for them.[3]

Diesel: quantity, not quality

Unlike almost all other countries where gasoline vehicles are more popular, diesel powered four-wheel drives rule the roost in India, and with good reason — the price of diesel is half the price of petrol here.

This is because the fate of diesel is closely linked with that of kerosene which is domestically used by the poorer sections of society. In the late 1980s, one-third of the domestic kerosene consumption was for lighting homes, and the remaining was used as cooking fuel. So kerosene prices have been subsidised by the government.

In the event of higher prices for diesel, retailers and some consumers would be tempted to adulterate it with cheaper kerosene. So diesel prices are also kept low, with a Rs 2,205 crore annual subsidy.[4]

Ironically, the biggest benefactors of both these subsidies are diesel vehicle manufacturers and urban consumers, and not the rural poor. While 70 per cent of the kerosene meant for the poor is presently used up by the urban population, the production of diesel vehicles rose from 43,000 in 1975 to 146,000 in 1990. Today, 70 per cent of the diesel manufactured in the country is used by the transport sector.[5] According to the Indian Institute of Petroleum (IIP), diesel constitutes almost 40 to 42 per cent of the total petroleum products' consumption in the country, and the refineries maximise its production to meet the demand. This results in a compromise on its quality.

'Cracking' is the term used to describe the process by which complex hydrocarbons are broken down. This could give rise to unsaturated carbon molecules in some cases, and thus instability. Refineries in India produce more diesel by cracking bottom-of-the-line 'heavy distillates' like vacuum gas oil (VGO). While the practice of increasing fuel obtained through such 'secondary processes' is common, the particular process used in India results in poor fuel quality. Most of our refineries have fluidised catalytic cracking (FCC) or delayed coking units for secondary distillation, and both processes produce unstable diesel.[6]

"FCC has emerged as the primary secondary conversion process in India, with some of the eastern refineries using the delayed coking process. But the quality of gasoline and middle distillates from these processes is clearly unsatisfactory," says Y Kumar, scientist at the IOCL research and development centre. Only the Gujarat IOCL refinery has a more acceptable hydrocracking unit which hydrogenates the unstable unsaturated hydrocarbons formed during the cracking process. "Hydrocracking is the most desired process to meet our ever increasing demand for middle distillates," says Kumar.

In order to increase diesel and kerosene production, refineries also take a larger 'cut' of these two fuels. The different distillates obtained from crude is separated by different

Table 3.2.2 **Projected vehicle population in India**

Year	Gasoline driven (in million)		Diesel driven (in million)
	2 & 3-wheelers	4-wheelers	
1993-94	15.9 (74.0%)	2.7 (12.5%)	2.9 (13.5%)
1995-96	19.5 (75.6%)	3.0 (11.6%)	3.3 (12.8%)
2000-01	32.2 (78.3%)	4.2 (10.3%)	4.7 (11.4%)
2006-07	53.3 (79.8%)	6.3 (9.4%)	7.2 (10.8%)

Note: Figures in parentheses are percentage to total population

SOURCE: 2

distilling temperatures. "Ours is one of the widest cut diesels in the world, " says K K Gandhi from the alternative fuels and conservation department of the IIP.

"To meet the growing demand for diesel, the technique of increasing the boiling range for extraction of a heavier fraction is often used," says D K Biswas. "This results in an increase in the sulphur and carbon content in the fuel, which in turn, causes vehicular exhaust containing particulates, smoke and sulphur dioxide."

Table 3.2.3 Diesel fuel specifications under EPA

Characteristics		Requirement
Density at 15°C, kg/m³		820 to 880*
Cetane number, minimum		45.0**
Distillation:	85% by volume recovery at °C, maximum	350
	95% by volume recovery at °C, maximum	370
Sulphur, % by mass, maximum		0.50***

Notes: * : 820 to 860 by 2000 AD
** : 48 by Dec 1998 (except Digboi, Guwahati and BRPL refineries)
*** : 0.50% by mass by April 1996, and 0.25% by mass by April 1999
kg/m³ : kilogramme per cubic metre

SOURCE: 12

Specifications have been proposed to control the distillation range (see Table 3.2.3) but refinery officials warn that this would have a serious impact on their productivity. "A preliminary study indicates that the proposed changes will have a serious impact on refinery operations and availability of diesel in the country," says Chaudhri. He estimates that the diesel production loss on account of this will be of the order of 2 to 2.5 million tonnes per annum, of the total present production level of about 19.5 million tonnes per annum.

Chaudhri is also worried about the increase in the generation of heavy ends in the refinery, if distillation temperatures are controlled. The Ministry of Petroleum, meanwhile, seems to be buying time. It has commissioned the Centre for High Technology to study the effect of the distillation range and other critical parameters of diesel on CO, HC, NO_x and particulate emissions from typical diesel engines produced in the country. The Rs 1.3 crore project is expected to be completed in December 1997. "It would be prudent to wait for the findings of this project before making changes in the distillation range specifications," says Chaudhri.

One of the important measures of diesel quality is its sulphur content. A high sulphur content in diesel contributes to increased emissions of particulate matter, responsible for the black smoke associated with diesel-powered vehicles. This smoke has been recently found to be more harmful than thought earlier. A study on the link between air pollution and mortality conducted in six cities in the US,[7] has established that mortality caused by air pollution is mainly associated with these fine particulates, less than 2 microns in size, which contain HCs and sulphates.

The sulphur content of diesel is first determined by the quality of crude used in its manufacture. Crudes low in sulphur are said to be 'sweet' or 'light', while high sulphur crudes are said to be heavy. The quality of crudes from new oil fields around the world seems to be deteriorating, and it is expected that crudes will gradually become heavier and higher in sulphur content.

So far, oil fields in India meet 45 per cent of our requirement (see Table 3.2.5).[8] The rest is imported through the Oil Coordination Committee of the Ministry of Petroleum. While Indian crudes are by and large low in sulphur, refinery officials allege that imported crude has a high sulphur content, since heavy crude is cheaper in the international market. India's crude imports have been increasing rapidly over the years, and refineries designed to process Indian crude have shifted to processing imported

Table 3.2.4 BIS specifications for high speed diesel

	Present	Revised with immediate effect**	Proposed for 2000 AD
Density*	0.82-0.88	0.82-0.88	–
Cetane no (min)*	42	45	48
Carbon residue* (on 10%) % max	0.20 (on total)	0.35	0.30
Distillation:			
95% recovery			370
90% recovery	366	366	
85% recovery			350
Flash Point	32	32	35
Kinematic Viscosity cst at 40° C	2.0-7.5	1.8-5.0	2.0-5.0
Total sulphur, % max	1.0	1.0	0.25
Total sediments (mg/100 ml) max	1.0	1.60 (uop)	1.60 (uop)
Water content % v max	0.05	0.05	-

Notes: * : see glossary ** : Indian Standards 1460, 1995
min : minimum max : maximum
mg : milligramme ml : millilitre
% max : maximum percentage BIS : Bureau of Indian Standards

SOURCE: 3

crude, without adapting their technology to the requirements of the high sulphur crude that they now receive.

Added to this is the fact that none of the refineries in India have diesel hydro-desulphurisation (HDS) units. The sulphur content of diesel in India is presently 1 per cent by weight. The diesel supplied to the four metros is expected to have a reduced sulphur content of 0.5 per cent by April 1996, and the sulphur content for all diesel supplies will be brought down to 0.25 per cent by the year 2000.

To meet the 0.25 per cent specification envisaged for the year 2000, HDS units will have to be installed in all refineries. The cost of installing these units is estimated to be about US $1 billion (about Rs 3,500 crore), estimates Shiv Narain Mathur, director (production), Hindustan Petroleum Corporation Ltd (HPCL).

The industry is presently planning nine HDS units for the IOCL refineries at Gujarat, Haldia, Mathura and Panipat, BPCL, Cochin Refineries Limited (CRL), Hindustan Petroleum Corporation (HPC) refineries at Mumbai and Vishakhapatnam and Madras Refineries Limited (MRL). "But it will be at least two years for them to be installed," says S P Srivastava, general manager, IOCL (R&D).

The current specifications of the cetane number or ignition quality of diesel in India is also very low compared to those in other countries. The current specification is 42, which is to be increased to 45 with immediate effect, and to 48 by 1998. Chaudhri anticipates no problems in meeting these specifications, except in the case of the north-eastern refineries. "The three IOCL refineries in Digboi, Guwahati and Barauni, and the Bongaigaon

Table 3.2.5 Break-up of crudes processed (%)

	1985-86	1990-91	1992-93
Indian crudes:			
Mumbai High	45.3	39.4	25.4
Gujarat	9.7	11.9	10.3
Assam	11.1	9.5	8.9
Others	0.1	0.7	0.6
Total	66.2	61.5	45.2
Imported crudes:	33.8	38.5	54.8

SOURCE: 6

Refineries Private Limited (BRPL) process Assam crude which is high in aromatics and hence yield low cetane number diesel," he says. "It will not be possible for these refineries to upgrade their cetane number to 45 or 48 with the addition of a cetane improver alone. Alternative strategies will have to be worked out."

AMIT SHANKER / CSE

Due to the unavailability of unleaded petrol outside the metros, 'greenwheels' owners prefer the simple procedure of 'bypassing' the catalytic convertor

Gasoline: below par

Legislation relating to gasoline quality in various countries is centered around its lead, benzene and oxygenates content. The main emissions from gasoline vehicles which need to be controlled are lead, CO, HC and SO_2. The most notorious of these is CO, which tops the list of air pollutants from all sources, and the major share of which is emitted by petrol vehicles.

Catalytic converters were fitted in cars in the US a decade ago to reduce CO and unburned hydrocarbons, alongside the introduction of lead-free gasoline. The two measures have to go hand in hand, as the presence of lead in gasoline poisons the catalyst used in convertors and renders them ineffective.

In India, the first step towards dealing with the problem was taken in April 1995, when catalytic convertors and unleaded gasoline were introduced in Delhi, Mumbai, Madras and Calcutta. It is expected to be available to the rest of the country by the year 2000. In the meantime, the lead content in fuel available in the rest of the country is to be reduced from its present level of 0.56 gm/l to 0.15 gm/l by December 1996.

But the wisdom of introducing catalytic convertors and unleaded petrol in this phased manner is questionable. Within the first few months, vehicles commuting to satellite towns around these four cities either ruined their catalytic convertors because unleaded petrol was not available in these towns or had them removed. Meanwhile, several hundred crore of rupees have been spent on providing unleaded fuel to the 150-odd petrol bunks in the four cities. So far, Indian refineries have managed to provide these outlets with unleaded fuel by altering processes without investing in more equipment. But providing the whole country with unleaded fuel will be an altogether different ball game.

Tetra ethyl lead (TEL) was traditionally an additive used to boost the octane number of gasoline (a rating which indicates the tendency to knock when a fuel is used in a standard combustion engine under standard conditions). It was introduced in the US in 1923, in order to improve the combustion properties of gasoline. Car engine manufacturers then realised that engine output power and fuel economy could be improved with an increase in the engine compression ratio. The higher compression ratios, however, caused a 'knocking' in the engines which was not only annoying, but also damaged the engine.

But it was found that small quantities of lead in the engines reduced the knocking, and lead became a cheap 'anti-knock' additive. The anti-knock characteristic, meanwhile, came to be measured by its octane rating. The octane number became an important performance criterion of gasoline. In most countries, its value is determined through an average of two values — the research octane number (RON), which is an overestimate of the anti-knock behaviour of gasoline, and the motor octane number (MON), which is an underestimate. The anti-knock index is an average of the two [that is, the anti-knock index = (RON + MON)÷2].

While RON is a measure of gasoline's anti-knock quality under low-speed, light-load driving

An unpopular move

Unsuccessful introduction of catalytic convertors and unleaded fuel in the four metros

In Delhi, catalytic convertors and unleaded fuel have not been popular with the consumer, and car owners prefer to register their vehicles outside Delhi or carry out simple 'by-passing' the catalytic convertors alterations. This 'by-pass' on a catalytic convertor-fitted vehicle can be done in under two hours at almost any neighbourhood mechanic or service station for between Rs 250-400. The monitoring and implementing agencies do not have estimates of the number of vehicles which may have done away with the use of catalytic convertors.

Short supply

"The main reason is the issue of availability of unleaded petrol (ULP), especially on routes out of Delhi," admits an Oil Coordination Committee (OCC) official. The OCC has set 1998 as the target for ULP to be available in all state capitals and union territories and the year 2000 for the entire country.

According to state-level coordinating committee sources, ULP supply in Delhi was based on the assumption that vehicles fitted with catalytic convertors would use 80 litres each of ULP per month. For the 31,637 petrol-driven four-wheelers registered (see Table 1) between April 1 and October 31, 1995 in Delhi, the four oil companies had supplied (see Table 2) 2,685 kilolitre (kl) to 105 petrol bunks

Table 1 **No. of new petrol vehicles registered in Delhi**

Month/Year	4-wheelers	2-wheelers	Goods vehicles	Taxis	Buses	3-wheelers
As of Mar 1995	575,762	1,617,732	125,071	12,547	26,202	74,981
Additions in Apr-Oct 1995	31,637	69,632	5,437	646	1,041	2,313
As of Oct 1995	607,399	1,687,364	130,508	13,193	27,243	7,729,419

SOURCE: 1

(there are 264 bunks in the city). Thus as per estimates, the 31,637 petrol vehicles, would need a supply of 2530.96 kl of ULP in Delhi, leaving an excess of 154.04 kl.

While this seems to go against the belief that there is a rampant conversion to by-pass the catalytic convertor, vehicles registered outside Delhi also exist. Ajay Aggarwal, who lives across the border in Faridabad, is an executive working at Connaught Place, and has booked a Maruti car with an agency in the same area, Allied Motors. Though he has booked the vehicle in Delhi, he has asked the dealer to register the car in Haryana, something that is perfectly legal, he hastens to assure.

"Had unleaded petrol been freely available, I would have definitely registered the car in Delhi," he states. He has taken this step despite the fact that vehicles registered in other states cost more than those registered in Delhi, where low taxes reduce the cost of the car. The reason — he travels out of Delhi often and would not like his journeys to be hindered by the unavailability of ULP.

Not one culprit alone

Though critics were of the opinion that the entire exercise made almost no difference to the net vehicular pollution as petrol driven four-wheelers fitted with catalytic convertors comprise merely 5.21 per cent of the total cars in Delhi, or 1.24 per cent of the total vehicle population on its roads, Central Pollution Control Board (CPCB) believes that the lead content emitted would come down considerably (see Table 3) during implementation of the programme. A major contributor, they contend, is the introduction of low-lead petrol in the metros from June 1994.

Table 2 **Supply of unleaded petrol in Delhi**

Month 1995	Unleaded petrol (in kilolitres)
April	165
May	502
June	947
July	1,443
August	1,822
September	2,154
October	2,685

SOURCE: 2

However, critics like Sunil Kale, associate professor at IIT, Delhi, argue that poor technology even in new vehicles, combined with poor quality petrol, improper traffic control systems, rapid increase of personalised vehicles and an inefficient mass transport system, would nullify any steps taken to reduce vehicular pollution."The main culprits of vehicular pollution are the two-stroke two-wheeler engines and three-wheeler autorickshaws manufacturers. There is no use in fitting catalytic convertors on four-wheelers, while these vehicles are allowed on the road," Kale states. He contends that this is just another scheme to milk the public of funds. "The owners of the 2.5 million (25 lakh) vehicles pay Rs 37.5 million (Rs 3.75 crore) a quarter or Rs 140 million (Rs 14 crore) a year, just for the pollution certificates. How much of this money is used to ensure that vehicular pollution is actually reduced? What does it actually cost to get a pollution check carried out? Who are the manufacturers of these pollution checking devices, and how many units have they sold over the recent past? And this is not counting the money that vehicle inspectors and others must be making when drivers are caught without the certificate."

Table 3 **Lead emissions in the metros**

Metros	Gasoline consumption (mt)	Pb content (gm/l)	Total Pb emissions (mt)
1993-94			
Delhi	373,744	0.56	203
Mumbai	238,616	0.56	130
Calcutta	57,742	0.56	31
Madras	92,796	0.56	51
1994-95			
Delhi*	65,799	0.56	86
	340,663	0.15	
Mumbai*	40,468	0.56	55
	228,729	0.15	
Calcutta*	9,212	0.56	12
	50,522	0.15	
Madras*	14,238	0.56	20
	82,205	0.15	

Notes: mt : metric tonnes Pb : lead
gm/l : grammes per litre
* : The first set of figure is upto April 1994, before unleaded petrol was introduced.

SOURCE: 3

While this may remain a matter of conjecture and assumption, the government must do more than just ensuring that unleaded petrol and ordinary petrol cost the same and that the ex-factory cost of cars fitted with catalytic convertors is the same as those without. Whether cars are registered in Delhi or not, or whether the catalytic convertor is done away with, would hardly make a difference to the poor quality of air.

Table 3.2.6 Motor gasoline specifications under EPA

Characteristics	Requirement
Reid vapour pressure at 38°C, KPa	35 to 70
Benzene, per cent by volume, maximum	5.0*
Lead content, gm/l, maximum	0.15 (low leaded)**
	0.013 (unleaded)
Sulphur, per cent by mass, maximum	0.10 (unleaded)
	0.20 (unleaded)
Potential gum, gm/m^3, maximum	50
Gum (solvent washed), gm/m^3, maximum	40
Oxygenates content, ether, MTBE, ETBE, alcohol, per cent by volume, maximum	15
Phosphorus	–***

Notes: KPa : Kilo Pascal
* : 3.0 per cent by volume maximum in metro cities by 2000 AD
** : 0.15 gm/l by December 1996 (for entire country) 0.013 gm/l by April 1995 (in metros) by December 1999, for entire country
*** : Phosphorus containing additives shall be absent
EPA : Environment Protection Act
gm/l : gramme per litre
MTBE : methyl tertiary butyl ether
ETBE : ethyl tertiary butyl ether
gm/m^3 : gramme per cubic metre

SOURCE: 12

conditions, when engine temperatures are not very high, MON is a measure of the fuel's performance at high speed and high load, when engine knock can lead to engine damage. Thus MON is usually the more critical specification. Petrol ratings range from 80-100 in RON and 70-90 in MON, with the lowest values in developing countries that have outdated refining technology. India has no MON specification at present, though an anti-knock index of 84 has been proposed for the year 2000.

The higher the octane number, the better the performance of the vehicle, and the lesser the emission. "Lowering the octane rating by one number reduces engine fuel economy by about 1.5 per cent when the engine's compression ratio is lowered to match the fuel," says H B Mathur of the mechanical engineering department of IIT (Delhi). The octane quality of fuel (anti-knock property of fuel) available in most advanced countries is much higher than that in India (see Table 3.2.7). In 1983, the specification was increased from 79 to the current level of 87 (RON), to meet the requirement of the new generation Maruti cars. That means, when compared to Germany's gasoline rating of 100 RON, India's engine fuel economy is 19.5 per cent lower simply because of the fuel octane rating.

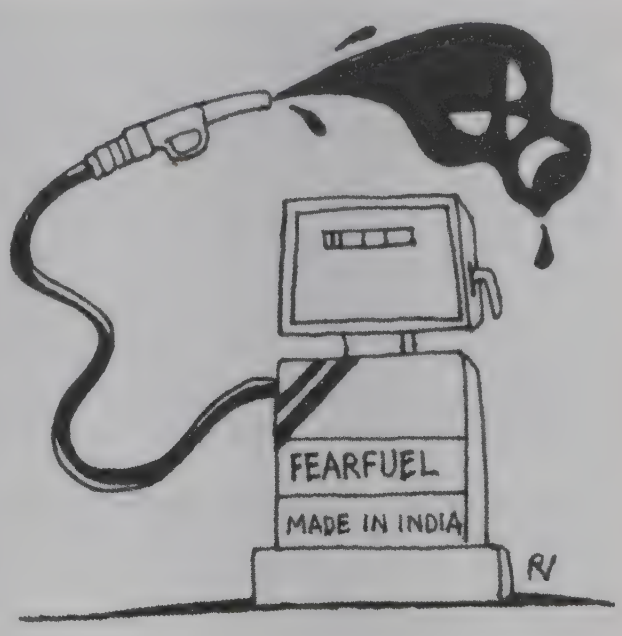
Unleaded fuel, on the other hand, is manufactured by using aromatics instead of TEL. Aromatics consist mainly of benzene, toulene, xylenes and ethyl benzene. Benzene, a volatile and highly toxic substance, is emitted into the atmosphere by evaporation through the vents of the fuel tank in cars, the carburettor and intake system, and also through the exhaust. Benzene makes its way into gasoline either through the aromatic reformate added to increase the octane number instead of TEL, or during secondary manufacturing processes like FCC and delayed coking. A sample of leaded petrol with an octane rating of 98 RON, for example, would have an aromatic content of 29 v%. But in unleaded petrol, this has to be increased to around 43 per cent to obtain 98 RON. The high aromatic content of unleaded fuel also results in greater emission of carcinogenic polyaromatic hydrocarbons (PAH).

In the US, Germany and some other countries, benzene content in gasoline is restricted to 1v%. No specifications exist for benzene content of fuel in India but present levels are estimated to be as high as 7-10 v%.[2] Rough estimates from refinery officials claim that an investment of US $90 million will be required to meet the benzene specification of 5 per cent. If levels are further brought down to 1 per cent of volume,

they claim, the estimated loss of gasoline will be in the range of 2 million tonnes per annum.

To meet benzene specifications Indian refineries need to install new units for alkylation and isomerisation, and use oxygenates like methyl tertiary butyl ether (MTBE), ethyl tertiary butyl ether (ETBE) and tertiary amyl ether (TAME).

The addition of such oxygenates to fuel is beneficial in many ways. It replaces lead as an additive to increase the octane number of gasoline and also improves combustion, thus reducing emissions. The practice of adding oxygenates began by blending methanol and ethanol to fuel. Several companies marketed this mixture as 'oxy-fuel'. In Brazil, where ethanol is cheap and easily available, pure ethanol as well as ethanol-gasoline blends are marketed as motor fuels. Similar experiments have been carried out in India. In the US, the Clean Air Amendment Act stipulated a 10 per cent replacement of HC with a renewable resource like ethanol.[1]



The most acceptable oxygenate so far, however, has been MTBE, which is produced using methanol and isobutene. The production of MTBE has recorded the fastest growth rate for a chemical, shooting up from 3.5 million tonnes per year (tpy) in 1986, to 20 million tpy in 1993. Ether oxygenates are now added to fuel in most countries of the world, barring a few developing countries like India.[1]

The US has made it mandatory for fuel to contain a minimum of 2 per cent (by weight) of oxygen, which corresponds to 10 per cent (by volume) of MTBE. A 2 per cent increase in the oxygen content of gasoline reduces CO emissions by 20 per cent, and unburnt hydrocarbons emissions by 10-12 per cent.

As in the case of diesel, fluidised catalytic convertor as a secondary refining process, is also used for gasoline to increase productivity. But gasoline produced through this process has a tendency to form gum, which deposits on the carburettor and the valves in the carburetted engine system. This leads to an increase in fuel consumption and a corresponding increase in emissions. During studies carried out by IOCL, it was found that even cars which had covered only 10,000 km had gummy deposits.

The refineries would have to change their refining processes and add anti-oxidants, detergent and dispersant in the fuel to stop this gum formation. The IOCL research and development centre experimented with fuel containing additives, and

Table 3.2.7 Octane number of gasoline in other countries

Country		RON	MON
US	leaded	87;97	82;87
	unleaded	88;96;100	80;87;94
Japan	leaded	98	87
	unleaded	91;98;100	83;87;88
UK	leaded	90;93;97	80;82;96
	unleaded	95	85
Germany	leaded	91;94;98;100	82;85;88;90
	unleaded	91;95	82.5;85
USSR	leaded	80;93;98	76;85;89
	unleaded	80;93;95	76;85;86

Notes: RON : research octane number
MON : motor octane number

SOURCE: 6

On the lookout

The search for alternate fuels has not yielded anything concrete so far

The media regularly reports breakthroughs in the use of alternative fuel for the transport sector. None have been popular so far but researchers allege that this is because it does not suit the rich and powerful oil lobby to have an alternative to their product. But do any actually hold promise?

Researchers at Indian Institute of Petroleum claim that compressed natural gas (CNG) and alcohols are promising potential fuels for large-scale introduction in India. "Worldwide, there are already about 700,000 CNG and 8,000,000 alcohol-powered vehicles operating commercially," says K K Gandhi, head of the alternative fuels department of IIP.

Possible substitute among alcohols

Technically, both ethanol and methanol can be used as part or complete replacements for diesel and gasoline. IIP has been working on these two alcohols since the 1980s and carried out field trials on scooters, motorcycles, mopeds and diesel buses. "Substituting a mix of alcohol and diesel or gasoline does not require any modification to the existing engine," says Gandhi.

In Brazil, where ethanol is in abundance, 40 per cent of the vehicles use 100 per cent ethanol, while the rest blend it with gasoline. But the problem in India is the availability of these alcohols since the use of molasses is rationed by the government for the drug and potable alcohol industry.[1]

Recently, when alcohol was banned in Andhra Pradesh, the distilleries in the state were in a fix. But they found an unlikely customer in the Andhra Pradesh State Road Transport Corporation (APSRTC). APSRTC has a plan to convert its fleet of buses to run on an alcohol-diesel mix called Diesenol.[2]

Diesenol is reported to increase energy efficiency of combustion by upto 5 per cent. Smoke is reduced by 40 per cent and exhaust heat is cooler, along with a reduction in CO and NO_x emissions. But the possibility of other harmful emissions unique to alcohol have yet to be ruled out.

H B Mathur of the Indian Institute of Technology (IIT), Delhi has been working on alcohol as a substitute fuel for the past 27 years and claims that alcohol could be added to fuel right away for a 10-15 per cent saving on fuel and 35-50 per cent reduction in pollution. It is somewhat ironical that Mathur's expertise has been called upon by the Americans and the Brazilians, while there have been few takers in India itself. (Mathur assisted the Agricultural Product Utilisation Committee set up in Nebraska in the 1970s.)

"India has more alcohol than is presently being utilised in the country and we are presently exporting the excess," he says. "But the chemical industry has taken on a dog-in-the-manger attitude by claiming that they will require the excess fuel for their expansion." Recently, DCM and a Tamil Nadu-based company, Vairam Agro Industries, have sought permission to market an alcohol- and-fuel mix, but the projects are still to come through.

No permanent solution

Compressed natural gas (CNG) is another alternative to gasoline vehicles, though not a long-term one, since it is again a non-renewable resource. So long as the subsidy on diesel exists, CNG will not be a cheaper option for diesel vehicles, though it is cheaper than petrol. According to Mathur, Gas Authority of India Limited (GAIL) started promoting the use of CNG only after the international community started criticising it for flaring the gas. A few years ago, GAIL introduced CNG as an alter-

nate fuel in Delhi, Mumbai and Baroda. The CNG conversion kit was made available for about Rs 35,000. Consumer indifference ended the project in Delhi but it found acceptance in Mumbai. B S Negi of GAIL estimates that Mumbai High can easily provide CNG for about 18,000 cars in the city. This is about 12 per cent of the total CNG produced by Mumbai High.

About 2,000 taxis in Mumbai are already using CNG and enjoy the advantages of soot-free and more regular combustion, high octane characteristics, longer life of engines, and longer oil drain intervals (see Table). But there are disadvantages in the form of reduced trunk space. The CNG tank takes up five times more space than the conventional fuel tank, which means additional weight. "CNG is cost-effective and many more drivers are willing to switch to its use," says S Quadros, general secretary of the Mumbai Taximan's Association. The gas costs Rs 10.60 per kg and gives about 18 km mileage, while one litre of petrol costs 21.14 and gives only 10 km mileage on the congested roads of Mumbai.

Table Comparison of emission from CNG and petrol cars

Vehicle	Petrol		CNG		Reduction	
	CO (%)*	HC (ppm)	CO (%)*	HC (ppm)	CO (%)*	HC (ppm)
Premier	2.67	430	0.1	60	96	86
Maruti 800	1.5	418	0.4	78	73	81
Ambassador	2.0	1,200	0.15	80	93	93
Gypsy	2.5	200	0.7	85	72	64
118 NE	1.5	500	0.1	70	93	86

Notes: CNG : compressed natural gas ppm : parts per million
CO : carbon monoxide HC : hydrocarbons * : to total emissions

SOURCE: 3

But the initial enthusiasm among taxi drivers has considerably dampened due to the non-availability of CNG. There are only three filling stations in Mumbai and taxi drivers complain that they have to queue up for hours for a filling, and supply is inadequate and erratic. "We require 7-8 kg of gas per day but we get only 3-4 kg," laments Quadros.

After irate taxi drivers threatened to pull out the CNG kits, installed at a cost of Rs 32,000 per vehicle, a joint meeting was held between GAIL, the Automobile Association of India and the state government. GAIL gave an assurance that it would open more filling stations in Mumbai within six months but nothing has been done so far. GAIL officials explain that unless pipelines are set up, the supply of gas will remain restricted, since transportation of gas through cylinders has its own limitations. Officials indicate that it may take another two years to establish the network of pipelines. "This is too long to sustain the interest of the taxi drivers," says Quadros. "They will have to come up with intermediate solutions fast."

CNG refuelling also requires a different procedure. There are two different systems — slow fill and fast fill. The slow fill system takes more time and is usually carried out overnight, while the fast fill system takes 3 or 4 minutes but requires storage cascades at high pressures of 250 bar. This makes marketing of CNG a problem, as refuelling stations would need compressors worth crore of rupees. Implementation of CNG requires huge investments in infrastructure. Since CNG is not a permanent solution, doubts have been raised whether it is really worth all the trouble.

Table 3.2.8: BIS specifications for gasoline

	Present	Revised with immediate effect*	Proposed for 2000 AD
Density	No limit		0.70 - 0.75
Sulphur % by weight, maximum	0.25	0.20	0.10
Potential gum (gm/m3)	-	50	50
Reid vapour pressure (Rvp) at 30°C, KPa	70 max	35-70	35-60
Vapour lock-index, maximum			
Summer	-	750	750
Winter	-	900	900
Benzene v%, maximum		No specification	5.0
RON, minimum	87 (ord)	87 (ord)	
	93 (pre)	93 (pre)	
Antiknock index (RON+MON)/2	82 (ord)	84 (ord)	
	88 (pre)	88 (pre)	
Lead content (gm/l)	0.56 (ord)	0.56/0.013	0.15/0.013
	0.80 (pre)	0.80	0.01
Oxidation stability (minutes)	360	-	
Oxygenates content — Ether (MTBE, ETBE) alcohol, per cent by volume (max)	No specification	15	

Notes: * : Indian Standards 2796, 1995 yet to be published ord : ordinary pre : premium
RON : research octane number MON : motor octane number
MTBE : methyl tertiary butyl ether ETBE : ethyl tertiary butyl ether
v% : per cent by volume KPa : Kilo Pascal

SOURCE: 13

found that CO emissions from cars running on commercial gasoline increased significantly with mileage, whereas in cars running on gasoline which contained additives, the increase in CO emission was negligible.

The vapour pressure of fuel in India at 0.7 bar, is high for a tropical country. This means a higher rate of evaporation, particularly of volatile organic compounds (VOCs), from tanks, fuel lines, during transportation and fuel transport in retail outlets. VOC emissions are closely dependent on the Rvp of gasoline as well as ambient temperature.

These VOCs combine with atmospheric NO_x react photochemically and form ozone, which causes lung irritation and respiratory problems. In the US, it was found that ground level ozone was increasing and 100 metropolitan areas failed to meet the standard of 120 parts per billion (ppb). Reid vapour pressure (Rvp) for reformulated gasoline was lowered to 0.5 bar to decrease ground level ozone formation.

Dealer and consumer

The quality control laboratories of refineries issue certificates for the fuel that leaves their premises, guaranteeing that it conforms to BIS standards. The fuel is then distributed to dealers appointed by the refineries and the civil supplies department. But, once again, the refineries themselves are responsible for checking petrol bunks, to ensure there is no adulteration. The refineries have mobile check vans which send back reports to their marketing divisions. Several cases of malpractice by dealers have been

T C MALHOTRA / CSE

The enthusiasm with which CNG was received after it was introduced as an alternate fuel in Mumbai has dampened with its non-availability and the inconvenient refueling procedure involved

uncovered by these checks in the past, and licences have been cancelled.

Fuel, particularly diesel, is also adulterated by three-wheeler and truck drivers. "The vehicles do not belong to them, so they do not worry about the engine being ruined," says Srivastava from the IOCL research and development centre. Kerosene oil is the usual adulterant, though petrol dealers also use other solvents like hexane, benzene and naphtha. In order to discourage retailers from using kerosene as an adulterant, the refineries have recently started colouring it blue.

As mentioned earlier, the price of diesel and kerosene are controlled to discourage adulteration. But the difference between the price of diesel and kerosene has been widening over the years which is incentive enough for the petrol bunk owners and for truck drivers to go ahead with tampering fuel quality.

Meanwhile, the diesel subsidy is encouraging freight movement by road, adding to vehicular pollution. Cheap diesel means that freight movement is cheaper by road than by rail, resulting in more polluting diesel vehicles on the road, using adulterated fuel in all probability. Freight movement by road is more energy inefficient than rail transport. In 1970-71, 66 per cent of freight traffic was by rail. It fell to 62 per cent in 1980-81, and further to 47 per cent in 1991-92. The situation is all the more fraught because if petroleum prices are decontrolled, the price of freight increases, resulting in inflation. Decontrol will also mean taking on the wrath of the truck lobby and vehicle manufacturers who are making the best of the diesel subsidy.

It is no wonder, then, that Kelkar rules out the possibility of deregulation until after the 1996 elections. The then Finance Minister, Manmohan Singh, who also addressed the oil and natural gas conference, cautioned that while liberalising the pricing policy, the government would have to carefully examine its impact on various consumers first.

It is clear that the politics of vehicular pollution goes beyond just badly maintained cars and two-wheelers and vehicle-owners who are fined during pollution control drives by a righteous administration are often paying for somebody else's inefficiency. The polluter should pay but only after a fair trial.

3.3 The maintenance–emissions nexus

AFTER being hounded for poisoning the air, the Association of Indian Automobile Manufacturers (AIAM) confessed in a presentation to the Ministry for Environment and Forests (MEF) on *Emission Profiles: On-road and New Vehicles* that vehicles contribute to more than 60 per cent of air quality deterioration in India. But this admission came with a rider: "We did not make these vehicles that way!"[1]

The manufacturers were hinting at the 30 million old and poorly maintained vehicles plying on the roads, making a mockery of all efforts to clean up the air. "New emission-efficient vehicles with 80 to 90 per cent reduction in emission levels are going to account for only 10 per cent of the total vehicle fleet on-road," says S J Shah, former AIAM executive director. "What difference would that make to the overall air quality? *Unless attempts are made to reduce emissions from the older vehicles, new vehicles, which in any case are going to be better designed to meet emission standards, will not make much impact.*"

Says B Ghosh from the Automotive Research Association of India (ARAI), "apart from ensuring emission efficient vehicles, it is also important to check progressive deterioration of vehicles to check subsequent rise in emissions." AIAM says that (see Table 3.3.1) in 1989, when there were no emission norms, 1.8 million new vehicles were added to the already existing 18 million vehicles on Indian roads, and altogether they emitted pollutants totalling 26,000 tonnes per day (tpd). By 1996, the total vehicle population will be 32 million vehicles, including 2.7 million new vehicles, and the emissions will increase by 66.3 per cent (43,300 tpd).[1]

Table 3.3.1 **Emission levels of vehicles in India**

Year	No. of vehicles (millions)		Pollutants emitted (tpd)
	New	Total	
1989	1.8	19.8	26,000
1996	2.7	32	43,300
2001*	3.5	49	62,785

Notes: * : approximate figures
tpd : tonnes per day

SOURCE: 1

The upshot of the argument is that unless the new emission controlled vehicles are maintained properly, they will soon lose emission efficiency. Therefore, the 1.8 million new vehicles which emitted only 360 tpd in 1989 are likely to belch 13,900 tpd by 1996, since they have deteriorated due to improper maintenance. By 2001, vehicles are expected to emit only 216 tpd but due to bad maintenance, they are likely to emit more.[1]

No comprehensive study has been done by the Central Pollution Control Board (CPCB) or any other state agency to quantify the impact of maintenance on the reduction of emissions. AIAM estimates suggest that with controls on fuel, maintenance and traffic planning, the emission levels of 18 million pre-1989 vehicles can be brought down to 20 per cent of the present 26,000 tpd.[1] H B Mathur of the mechanical engineering department of IIT (Delhi) approximates that proper maintenance could reduce pollution by 40 per cent.

Indifferent government agencies

Though experts unanimously agree that maintenance plays a major role in combating vehicular pollution, the government's action on this has remained nebulous. The government started focussing on maintenance only when vehicular exhaust emission standards were laid down for the first time in 1990.

T C MALHOTRA

Earlier, only a few loose requirements were included in the amended Motor Vehicles Act of 1989, which made certificate of fitness mandatory for registration of public and commercial vehicles and for personal vehicles older than 15 years.

The 1990 vehicular emission rules imposed some obligations on users. Under it, it was mandatory that every motor vehicle be manufactured and maintained so that it does not emit smoke, visible vapour, grit, sparks, ashes or cinders. Owners of four-wheeler petrol vehicles had to ensure that their vehicles did not exceed idling carbon monoxide (CO) emission levels of 3 per cent by volume (v%); this was 4.5 per cent in the case of two- and three-wheelers. Diesel vehicles had a smoke density level at 5.2 Bosch unit and 75 Hartridge unit for vehicles carrying a full load at a speed of 60 to 70 per cent of the maximum rated engine speed, and a 65 Bosch unit limit for free acceleration.[2] Only a sub-inspector of police or an inspector of motor vehicles, was empowered to measure emission levels.

Attempts should be made to reduce emissions from older vehicles but if new emission controlled vehicles are not maintained properly, they will soon lose emission efficiency

In the revised norms for 1996, however, only the mass emission norms for manufacturers have been tightened and those prescribed for users have remained unchanged. The concerned ministries are still indifferent to this problem. The MEF claims that this is not part of its mandate, and that the Ministry of Surface Transport (MOST) should look into this matter. Though MOST officials admit that there is some talk on the need for comprehensive inspection and maintenance rules for old vehicles, nothing concrete has been done so far.

Therefore, the only legal recourse left is the amended Motor Vehicles Act of 1989, which makes a certificate of fitness mandatory for registration of public and commercial vehicles and for personal

vehicles older than 15 years only.

MOST officials indicate that there is a proposal for developing rules on maintenance and inspection, especially to focus on grading of vehicles according to age, defining their operative requirements, and scrapping unfit vehicles. But the official grapevine has it that the whole attempt might be aborted since such a move is not politically expedient in India, where economic reasons do not allow frequent replacement of vehicles. For the same reason, MEF has not shown much interest in the proposal to tighten norms for use of old vehicles. MEF has also been criticised for not legislating on after-sales care and inspection of new vehicles. At present, there is no law to ensure that emission control devices in the new vehicles are operating effectively.

Government hesitation to enact a comprehensive legislation to regulate the age and number of vehicles persists despite the rules under the Indian Motor Vehicles Act which empowers it to fix the age limit of the vehicles. These rules have never been evoked by state transport officials in any metro as the current political climate impedes such a move. Delhi State Transport Authority officials lament, "the strong transport lobby in Delhi always find ways to obstruct such a move. In fact, a few years ago, an attempt was made by the Delhi government to implement this section of the Act but it had to withdraw because of the hue and cry raised by the transport lobby." Section 59 of the Act stipulates that "...the Central government may, having regard to the public safety, convenience and objects of this Act, specify life of a motor vehicle reckoned from the date of the manufacture, after the expiry of which the motor vehicle shall not be deemed to comply with requirements of this act... No prescribed authority shall grant a certificate of fitness to such a vehicle."

T K Malhotra, president, Automobile Association of Upper India (AAUI), New Delhi, adds, "Resolving this issue is going to be most difficult. From time to time this issue has been brought up but legal recourse to resolve this seems very complex as this interferes directly with the individual's right to be mobile. Only a package of incentive and disincentives can be developed to encourage owners to give up their old vehicles."

Ironically, while the records of the enforcement agencies for emission rules show a very high proportion of law abiding vehicles on metro roads, the emission inventory of these cities do not show much improvement.

The Transport Commissioner's office is the apex agency for enforcement of vehicular emission norms in Mumbai. Due to poor infrastructure, this office can barely check about 5 lakh vehicles a year. The rest is covered by about 40 pollution under control (PUC) centres for diesel and 102 PUC centres for petrol vehicles. Says P Phadke, joint transport commissioner of Mumbai, "even if it is not possible to check each and every vehicle for pollution, the very fact that all vehicles during the time of renewing license or registration and tax payment for vehicles have to show the PUC certificate, indicates that all vehicles get covered by emission rules." He claims that this, combined with testing vehicles on the roads, ensures that more than 80 per cent of the vehicles in Mumbai are within the prescribed standards.

Table 3.3.2 **Number of vehicles inspected in Delhi**

Year	Fit	Unfit	Total	% of unfit
1991-92	98,798	22,645	121,438	18.64
1992-93	99,316	24,042	123,358	19.48
1993-94	98,433	17,365	115,789	14.99

SOURCE: 3

A big farce

But there is much room for improvement, as a survey of taxi drivers in Mumbai showed. Both taxi and auto drivers admitted that in Mumbai, a pollution under check (PUC) certificate can be bought for Rs 25.

Delhi's official records also show that there are more than 80 per cent law abiding vehicles.

Table 3.3.3 Results of random check of vehicles for air pollution in Delhi

	New vehicles	Old vehicles	Two-wheelers	Three-wheelers
Total number of vehicles checked	1,092	412	2201	595
Total number of vehicles passed	616	181	944	275
% that failed to meet standards	43.6	56.1	57.17	53.8

SOURCE: 4

During the last three years, on an average, only 17.7 per cent of the total vehicles inspected at the state-owned vehicle inspection unit at Burari in Delhi were declared unfit under the Indian Motor Vehicles Act (see Table 3.3.2).[3] The vehicular inspection unit at Burari issues certificates of fitness to all vehicles and also checks mass emissions before issuing or renewing the certificate. Therefore, it is even more strange that Delhi should still be so polluted when more than 80 per cent of the vehicles have been officially certified for PUC and fitness.

The official figures, however, clash with the results obtained after random checking of vehicles in May 1995, by the AAUI. According to its findings, 56.1 per cent of the total number of old Ambassador and Premier Padmini models failed to pass emission tests, and 43.6 per cent of the total number of new generation vehicles like Maruti 800, Maruti 1000, Zen, NE 118 and Contessa could not meet the permitted emission levels. Likewise, 57.1 per cent two-wheelers and 53.8 per cent three-wheelers, failed to pass the tests (see Table 3.3.3).[4] Significantly, on an average, only 40 to 50 per cent vehicles pass the pollution test daily in the capital. This means that nearly half the vehicles plying on Delhi roads are in need of repair or tuning to conform to the emission standards.

What is equally alarming is the scepticism expressed in the report prepared by the AAUI, based on its campaign about the genuineness of the PUC tests in many centres. The report alleges that it is impossible to test as many vehicles per day, as recorded by the PUC centres. AAUI estimates that any pollution test would take at least 2 to 3 minutes for parking and positioning of the vehicles, and another 6 to 8 minutes for testing and adjusting of carburettor, etc. Thus, on an average, each vehicle would take a minimum of 10 minutes for the test. Accordingly, only six vehicles can be tested properly per hour. Based on this estimate, the AAUI report comments: "It, therefore, raises doubts about the genuineness of the testing, when more than 100 vehicles are tested by any service station in one day, assuming 8 hours of work."[4]

Scientists from IIP indicated that, to a large extent, emission control efforts in metros would have to cope with the unequal mix of old and new vehicles. According to the estimates of B P Pundir and other IIP scientists, about 70 per cent of the vehicles on-road are old.[5] A comparison of mass emissions from old and new vehicles indicate some difference between the two categories (see Table 3.3.3).

The average CO and HC emissions from 14 new models of two-wheeler scooters of different make that were tested was 2.48 gm/km and 3.07 gm/km respectively. Engine models of small size averaged 7.95 gm/km of CO emissions. But CO and HC emissions from old vehicles with different mileage showed considerably high emission levels. One of the old models (which had completed 9,690 km) emitted 6.88 gm/km of CO and 6.27 gm/km of HC.[5]

But some vehicles with even greater mileage showed relatively better performance. One of the tested models, (which had covered 15,612 km) emitted 3.51 gm/km of CO and 5.73 gm/km of HC.[5]

In the passenger car category, it was evident that dated technology makes car models like Ambassador and Premier more polluting when compared to the relatively newer models. B S Negi from

the Gas Authority of India Limited (GAIL) has estimated that Ambassador and Premier models, respectively, emit 1,200 ppm and 480 ppm of HC, whereas 118 NE and Maruti 800 emit 418 ppm of HC. Similarly, while Premier and Ambassador models emit 2.67 per cent and 2.0 per cent of CO respectively, Maruti 800 and 118 NE emit 1.5 per cent.[6]

Legal framework for maintenance

At present, sections 56 and 59 of the Indian Motor Vehicles Act, 1989, govern the inspection and maintenance of vehicles. A certificate of fitness is issued under section 56, and, under section 59, the government has the power to fix the age of vehicles.

The regulatory norms of the Indian Motor Vehicles Act, mooted in 1914, were broadened only in 1989 to address the problems of pollution, road safety and road worthiness. Earlier, vehicles only had to meet rules related to equipment and maintenance. Under the amended Act, however, it became obligatory to obtain a certificate of fitness covering all provisions and rules of the Act.

Under the amended Act, commercial and public transport vehicles are not considered registered unless they carry a certificate of fitness. If a vehicle does not qualify for a certificate, then the reason would have to be given in writing by the prescribed authority. Furthermore, if the authority is not satisfied with the vehicle, the certificate can be withdrawn. The amended Act gives more power to the

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The genuineness of pollution under check (PUC) tests is highly debatable, especially since PUC certificates are purchasable. Top: The instrument to monitor vehicular emission levels at one of the pollution check centres

Table 3.3.4 Division of rule-making powers under Indian Motor Vehicles Act, 1989

Rule-making powers of the Central government	Rule-making powers of the state governments
• The width, height, length, overhang of vehicles and of load carried • The size, nature, condition of tyres including embossing of the date of manufacture and the maximum load carrying capacity • Brakes and steering gears • The use of safety glasses including the prohibition of the safety tinted glasses • Signalling appliances, lamps and reflectors • Speed governors • The emission of smoke, visible vapour, sparks, ashes, grit or oil • The reduction of noise emitted by the vehicles • The embossment of chassis number and date of manufacture • Safety belts, handle bars of motor-cycles, auto dippers and other equipment for safety • Standards of components used in the vehicles as inbuilt safety devices • Provision for transportation of hazardous goods • Standards for vehicular emissions • Installation of catalytic converters in the class of vehicles to be prescribed • Warranty after sale of vehicles and norms thereafter	• Seating arrangements in public service vehicles and protection of passengers against the weather • Prohibiting or restricting the use of audible signals at times and places • The periodical testing and inspection of vehicles • The use of trailers with motor vehicles • All matters other than the matters specified for Central government

SOURCE: 1

Central government (see Table 3.3.4). The emission regulations of 1991 have been notified under this Act by the Central government.

Critics pointing out the inadequacy of the standards laid down for judging the roadworthiness of motor vehicles, feel that they need to be radically revised to deal with the emission problem. Says Shah, "even the criteria of testing the fitness of an old vehicle are not adequate. They only look for rusting, proper lighting, whether the engine stops when brakes are applied, and so on. The rules should actually lay down the schedule and define the periodicity for cleaning the engine and other requirements to ensure cleaner combustion."

While the parameters for judging the fitness of a vehicle from the pollution control view are inadequate, enforcement of the rules on certification for fitness is rather weak. In fact, a report filed by one of the inspecting officers of the State Transport Authority (STA), after inspecting the vehicle inspection unit at Burari, Delhi, made some significant observations: "While comparing average figures of the total number of certificate of fitness issued annually from the inspection unit at Burari, with the total number of vehicles registered which are required to have annual fitness inspections, it is observed that nearly half of the said vehicles are not coming up for the statutory fitness inspections. From this it can be apprehended that the certificate of fitness being issued in its present form is being counterfeited in alarming numbers

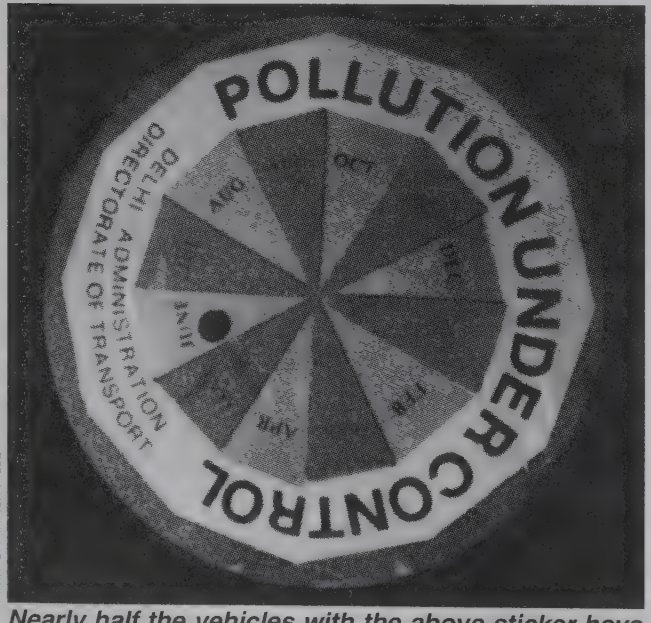
or that no proper checking is being done of the vehicles on the roads whereby a large number of unfit vehicles are plying on the roads."

Not only private vehicles but government-owned vehicles are also polluting the air in the metros. Though government-owned vehicles are liable to be penalised, enforcement is rather lax in their case. The near bankruptcy of the capital's Delhi Transport Corporation (DTC), for instance, makes a mockery of the pollution control drive by STA and attempts to penalise the state-owned vehicles. Poor and inadequate infrastructure, and inability to bear the cost of maintenance, impedes enforcement of rules.

The former Environment Minister, Rajesh Pilot, had a meeting with CPCB officials in December 1995, to identify action to reduce vehicular pollution in Delhi. Following the meeting, the officials visited the DTC central workshop in Okhla, to check calibration of instruments and the methodology for monitoring emissions. They found that DTC has only four smoke meters to test a large fleet of 2,950 buses in 33 depots. Even the monitoring system was at fault as testing machines were not calibrated before starting to measure emissions.

Lack of awareness

Consumer forums like the AAUI are planning to organise awareness camps to sensitise vehicle users to the need for regular maintenance operations. "The indifference of the personal vehicle owners towards proper maintenance is disturbing. They do not take their vehicles to the service stations unless there is something apparently wrong. Most vehicle owners are ignorant about tell-tale signs and fail to take pre-emptive measures. Though manufacturers of vehicles provide the service stations with detailed brochures on the maintenance schedule and method for different models of vehicles, most of it is never applied as the owners do not show much interest," says T K Malhotra. For instance, if there is a change in the sound of the vehicle, the cause should be identified. Periodic and proper check-up of the exhaust system is crucial to keep emissions under check. Laments Malhotra, "how many vehicle owners are aware of the fact that in the normal course of things, the exhaust system lasts about 24 to 40 months and that after that period it should be replaced. Besides, Indian consumers are not yet very quality conscious and while replacing any part of the vehicle, they settle for cheap deals."



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Nearly half the vehicles with the above sticker have not undergone the statutory fitness inspections

Beyond the lack of awareness and indifference to proper maintenance of vehicles, there are more deep-rooted problems over which most private and public vehicle owners do not have control. Adulteration of fuel and sale of spurious auto components are cited as two major hurdles in ensuring optimum operative performance of vehicles.

Taxi drivers in Mumbai complain of adulterated fuel which plays havoc with the engine. While white kerosene is the common adulterant, taxi drivers allege that since kerosene is in short supply in Mumbai, the petrol pump owners have even begun to mix low-cost products like naphtha with petrol. The Mumbai Taximen's Association estimates that about 120 tankers of these products enter Mumbai every day, and finally find their way into fuel tanks. Equally alarming is the revelation that a thriving market has appeared for

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Since mileage is affected when engines are tuned to ensure a leaner mixture, Mumbai taxi drivers promptly revert to the original adjustment, thereby increasing pollution

recycled lube oil. Reportedly, a large number of clandestine workshops have emerged along the Mithi river near Kurla, Mumbai, where used lube oils are sulphurised and recycled.

The auto component market is flooded with spurious and sub-standard components. According to a study done by the Delhi-based National Council for Applied Economic Research (NCAER) on the auto component industry, about 40 per cent of all products sold in 1990-91 were spurious. This has serious implications because the large number of old vehicles in India often need replacements and provide a large market for auto components. For example, the demand for 80 per cent of the spark plugs, 90 per cent wheels and steerings is met by the replacement market. Therefore, quality control at this level is essential.

Many owners succumb to the temptation of buying cheaper but sub-standard components due to lack of awareness. S Quadros, general secretary of the Mumbai Taximen's Association says, "an integral part of the maintenance schedule is that all components are regularly checked for operative fitness, and replaced if they are worn out. But most taxi drivers cannot afford the replacement, and so go for cheaper and poor quality components." Those who ply taxis on rent, he says, do not have a stake in them.

But it is also going to take some time for the consumer to become wise to the significance of emissions. For many, fuel economy is the prime consideration and they resent any tinkering to the engine that reduces it. In fact, according to Quadros, most taxi drivers, when asked to tune their engine to ensure a leaner mixture, claim that the engine does not run smoothly and mileage is affected. So they promptly revert to the original adjustment to improve mileage — and increase pollution. Taxi owners complain that Premier models bought after April 1995, have poor mileage because they are fitted with catalytic convertors.

A joint proposal for a national-level plan for emission control in India was placed before the government in 1990 by scientists from the IIT, IIP, Automotive Research Association of India (ARAI) and others. It stated that along with the development of accurate measurement techniques for emission components and pollution level in the air, it is necessary to establish the impact of new and older vehicles in selected cities for proper planning. They had even proposed to work out a mathematical model involving multiple sources such as addition, destruction, diffusion and net addition of pollution.

3.4 Traffic non-planning

THE sale of cars and two-wheelers is on an unprecedented rise in India. As cities spread out, distances grow, and land-use patterns change, auto-dependence is on the rise; today people are forced to travel far — often just to accomplish day-to-day tasks. Annual vehicle sales in the country grew from 2.3 million in 1993-94 to 3 million in 1994-95 (see Table 3.4.1). According to the Association of Indian Automobile Manufacturers, the total number of vehicles is expected to hit the 53-million mark in 2000-01 AD, as compared to the present population of 32 million. The number of two- and three-wheelers, particularly, is estimated to grow at a rapid rate and constitute about 80 per cent of the total vehicular population in the year 2006-07, if present trends continue.[1]

These vehicles are mostly concentrated in the urban areas, leading to massive congestion and overcrowding. In Delhi, the total number of vehicles was a little over 0.5 million in 1981. It increased to 1.8 million in 1991 and 2.2 million in 1994. This is more than the total number of vehicles in Calcutta (4.75 lakh in 1991), Madras (5.73 lakh in 1991) and Mumbai (6.2 lakh in 1991) put together. Or take Mumbai — more than a quarter of the total vehicles in the state of Maharashtra ply only in the Greater Mumbai area of 603 sq km, constituting a vehicle density of 1,042 per sq km. The city also accounts for 64 per cent of the total cars in the state.[2]

It is estimated that by the year 2001, nearly one-third of India's total population of 1 billion will be living in urban areas. Rise in the urban population, increase in urbanisation and concentration of activities, will lead to an increased need for transport. The public transport systems in all cities are far from satisfactory, so there will be a further increase in private modes. This will increase the volume of traffic on roads and also increase pollution.[3]

It is apparent that not even stringent emission control legislation can help control vehicular pollution in the emerging situation. The increasing number of vehicles on the roads will undo any benefits that might accrue from controlling emissions through better technology and stricter emission norms.

Table 3.4.1 **Projected annual vehicle sales: 1994-95 to 2000-2001**

Year	Two-wheelers	Three-wheelers	Cars	Jeeps	LCVs, MCVs, & HCVs	Total
1994-95	2,400,000	90,000	240,000	60,000	195,000	2,985,000
1995-96	2,616,000	98,100	261,600	65,400	212,550	3,253,650
1996-97	2,877,600	107,910	300,000	71,940	233,850	3,591,255
1997-98	3,165,360	118,701	400,000	79,134	257,186	4,020,381
1998-99	3,481,896	130,571	550,000	87,047	282,904	4,532,419
1999-2000	3,830,000	143,628	700,000	95,752	311,194	5,080,660
2000-01	4,213,094	157,991	850,000	105,327	342,314	5,668,726

Notes: LCVs : light carrier vehicles MCVs : medium carrier vehicles HCVs : heavy carrier vehicles

SOURCE: 1

Table 3.4.2 Available road space in the three metros

City	Road length (in km)	Road area (sq km)	Road length (km)*	Road length (km)**	Transport area***
Calcutta	840	568.0	0.09	147.68	6.4
Mumbai	1,423	438.0	0.17	324.91	—
Delhi	1,595	446.3	0.28	357.38	—

Notes: * : per 1,000 of population ** : per 100 sq km *** : percentage of total area

SOURCE: 3

"Even stringent standards will not make a difference if the number of vehicles keep increasing," says Shakti Sinha of the Indian Administrative Service.

Besides, with the infrastructure already crumbling under the burden of 22 million vehicles, there is no way it can withstand the pressure of 53 million vehicles by 2001. The required land for automotive infrastructure is not available in India (see Table 3.4.2), where much of the land has a more important use in agriculture. Moreover, we are unable to afford the enormous capital cost of such systems and their large hidden costs. In the US, for example, the public cost of automobiles, even with an existing infrastructure, has been estimated at more than $1,000 per person per year.

The infrastructure also suffers from lack of planning. Already today, a little under a quarter of the land area in Delhi comprises roads. But even that is not sufficient, particularly in the congested areas of Old Delhi. This despite the fact that Delhi is one of the few cities which was planned carefully and there was scope for widening roads once the number of vehicles increased. In cities like Bangalore and Calcutta, where development has been largely unplanned, the situation is near breakpoint. "There is no space to widen roads further here in Calcutta," points out Dhrubajyoti Ghosh from the Calcutta Metropolitan Water and Sanitation Authority.

Bangalore is a prime example of the disastrous effects of sudden, unplanned development on the traffic infrastructure. Thanks to a spate of software companies that have sprung up in the city during the last few years, the population has shot up suddenly, resulting in a dramatic increase in the number of vehicles (see Table 3.4.3). It now stands second only to Delhi in the number of vehicles plying. But the roads are narrow, and there are no main highways or truck terminals to cope with this traffic. No effort

Table 3.4.3 Motor vehicle population in Bangalore

Year	2-wheelers	3-wheelers	Cars	Buses	Trucks
1990-91	458,860	17,379	82,204	23,665	601,059
1991-92	502,707	23,350	91,883	26,525	604,497
1992-93	522,617	24,748	92,095	32,833	692,535
1993-94	577,710	33,338	103,872	35,909	773,904
1994-95*	615,051	35,642	110,649	38,484	824,716

Note: * : till 31 August, 1995

SOURCE: 6

Table 3.4.4 World automobile production

Year	Production*
1950	8
1960	13
1970	22
1980	29
1990	36
1991	35
1992	35
1993	34

Notes: Figures for 1950-93
* : no of automobiles in millions

SOURCE: 7

has been made to improve the infrastructure either.

There is, in fact, no way out as several countries have already come to realise. To avert the realisation of this smog-and-gas mask nightmare, the number of vehicles on the road have to be controlled. The Worldwatch Institute has actually recorded a decline in world automobile production over the last four years, from 36 million in 1990 to 34 million in 1993 (see Table 3.4.4). In Europe, new car purchases dropped by 17 per cent in 1993.[7] Industrial countries have levelled off their production of cars mostly because of a slow population growth, and also because they have already witnessed the ill-effects of an explosive growth in the number of automobiles. Efforts to halt the growing dependence on vehicles have become the focus of pollution control drives in many parts of the world. To discourage the use of private vehicles, several countries have improved their public transport systems, introduced road pricing and user fees, increased the price of fuel, promoted non-motorised transport by making the roads safe for cyclists and pedestrians, and promoted telecommunication as an alternative to travelling.

Public transport systems in Indian cities

In India, the situation is somewhat complex. Public transport systems do not even cater to basic requirements, although only one in every 553 individuals owns a private vehicle (see Table 3.4.5).

"The system is caught in a vicious cycle — as more people put a demand on the already poor public transport system, find it lacking, and when they can afford it, resort to private vehicles for a more reliable option," points out N Ranganathan, head of the Transport and Traffic Planning Department of the School for Planning and Architecture (SPA), New Delhi. "The private vehicles, usually two-wheelers, are in fact more polluting and energy-inefficient because they underutilise carriage capacity."

Very little has been done so far to design an efficient public transport alternative. So far, ramshackle diesel buses have been the delivering messiahs. But while cars and two-wheelers are growing at the rate of 18.9 per cent and 11.5 per cent respectively, buses are lagging behind at 9 per cent. Car and two-wheeler production has gone up by 20 per cent per annum whereas the growth rate of bus production has gone up by only about 3 per cent over the same period. So, though Delhi has the maximum number of buses in the country, with no alternative urban rail transport system to depend upon, these, nevertheless, fall short of catering to as much as 60 per cent of the transport needs.[3]

Table 3.4.5 Population per passenger car

Country	1960-65	1970-75	1989
Brazil	74	22	10
China	No data	8,124	4,345
India	1,138	807	553
Japan	45	6	4
Mexico	59	26	15
US	3	2	2
Zaire	470	240	298

SOURCE: 5

The need for a high-capacity, low-polluting, low-energy alternative for Delhi has been obvious for many

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years now. Suburban rail systems are operating in Mumbai, Madras and Calcutta. In Mumbai, the rail system meets one-third of the total transport requirements. The corresponding shares for Calcutta and Madras are 20 and 13 per cent, respectively.[3]

The very first master plan for Delhi, prepared in 1951, stressed the need for such a mode of transport for the city, and suggested that a mass rapid transit system (MRTS) be built. Nothing was done. Alarm bells rang again in 1970, after the Metropolitan Transport Team (MTT) conducted a traffic survey and revived the MRTS idea. It recommended a 36-km underground track and a 99-km surface track. The cost of the project in 1970 was estimated to be Rs 780 crore. Once again, nothing concrete was done. M Dandavate, the then Railway Minister, summed up the situation nicely by saying, "where there is a will there is a railway, where there is no will there is a survey."[4]

To overcome the smog-and-gas mask nightmare, vehicle numbers have to be controlled — pollution control drives across the world are now focussing on providing reliable public transport systems

A Rs 4,860 crore MRTS project has recently been cleared by the Union Cabinet. The Japanese Overseas Economic Cooperation Fund has offered to loan 60 per cent of the money for the first phase, provided the project schedules are clear and airtight. The Union and state governments will share the rest.

Ironically, the Indian Railways already has an existing network of tracks in Delhi but is unwilling to operate a metro system. The Railways' unwillingness touches upon another delicate aspect of public

The lesser evil

A TERI study looks into the options available to solve Delhi's traffic problem

In India, very little planning goes into deciding transport alternatives and weighing the pros and cons of different options. But a study, jointly conducted by Ranjan Kumar Bose of Tata Energy Research Institute (TERI) and Gordon A Mackenzie of Riso National Laboratory, Denmark, looked into the different options available to solve Delhi's transport problem and at the same time reduce pollution.

Table 1 Estimated emissions in Delhi if the present situation continues (in thousand tonnes)

Pollutants	1990–91	1994–94	2000–01	2004–05	2009–10
CO	179.59	222.28	286.33	329.05	382.42
HC	73.00	90.35	116.39	133.75	155.44
Pb	0.10	0.13	0.17	0.19	0.22
NO_X	16.12	19.95	25.70	29.53	34.32
SO_2	2.27	2.81	3.63	4.17	4.84
TSP	0.36	0.45	0.58	0.67	0.77

Notes: CO : carbon monoxide; HC : hydrocarbons; Pb : lead; NO_X : nitrogen oxides; SO_2 : sulphur dioxide; TSP : total suspended particulates

SOURCE: 1

Using a computer-based software called Long Range Energy Alternative Planning (LEAP), Bose and Mackenzie considered five possible scenarios — a continuation of the present situation (the business-as-usual or BAU scenario); an improvement in the vehicular speed from an average of 20 km/hr to 40 km/hr; an increase in the share of buses; the introduction of a mass rapid transit system; and a maximum conservation scenario.

Table 2 Estimated emissions if vehicle speed is increased from 20 km/hr to 40 km/hr through better traffic management (in thousand tonnes)

Pollutants	1990–91	1994–94	2000–01	2004–05	2009–10
CO	179.59	184.21	237.29	272.69	316.92
HC	73.00	76.58	98.64	113.35	131.74
Pb	0.10	0.11	0.14	0.16	0.18
NO_X	16.12	12.88	16.59	19.06	22.16
SO_2	2.27	1.73	2.22	2.55	2.97
TSP	0.36	0.26	0.33	0.38	0.44

SOURCE: 1

They found that if the average traffic speed remained unchanged, and vehicle population continued to grow, fuel consumption will more than double by 2009–10 vis-a-vis 1990–91, as will the loading of different pollutants (see Table 1).

But if appropriate traffic manage-

ment measures succeed in improving the vehicular speed from 20 km/hr to 40 km/hr, fuel efficiency will improve for each mode of passenger vehicle, and result in saving gasoline and diesel. Pollution levels will hence be marginally lower than in the first scenario. There will be an overall saving of nearly 27 per cent of total energy by 2009–10 in this case, translating into an estimated gasoline demand reduction of 17 per cent and diesel demand reduction of 42 per cent.

Table 3 Estimated emissions if number of buses is increased (in thousand tonnes)

Pollutants	1990–91	1994–95	2000–01	2004–05	2009–10
CO	179.59	203.22	268.22	268.01	311.4
HC	73.00	82.88	94.72	108.85	126.51
Pb	0.10	0.12	0.13	0.15	0.18
NO_X	16.12	19.86	25.42	29.22	33.95
SO_2	2.27	2.86	3.74	4.30	5.00
TSP	0.36	0.46	0.62	0.72	0.83

SOURCE: 1

The total suspended particulate (TSP) levels are reduced by 42 to 43 per cent in this case (see Table 2), while SO_2 levels come down by 38 per cent, NO_X levels by 35 per cent, lead levels between 15 and 18 per

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Delhi urgently needs high-capacity, low-pollution, low energy transport, and although the idea to build a mass rapid transit system was mooted, nothing has been done

cent, CO by 17 per cent and HC by 15 per cent.

Under scenario 3, that is, if the number of buses are increased, the model estimates that there would be an overall improvement, over the first scenario effects, as far as emissions of CO, HC and lead are concerned, with a 19 per cent reduction in the loading of CO and HC, and a 24 per cent reduction in lead by 2000-01 (see Table 3). But the study assumes that the increase in the number of diesel buses will mean a decrease in the use of gasoline driven private transport, which may not necessarily be the case.

Table 4 Estimated emissions if mass rapid transit system is introduced (in thousand tonnes)

Pollutants	1990–91	1994–94	2000–01	2004–05	2009–10
CO	179.59	222.28	286.33	288.24	285.13
HC	73.00	90.35	116.39	117.16	115.90
Pb	0.10	0.13	0.17	0.17	0.17
NO_X	16.12	19.95	25.70	25.87	25.59
SO_2	2.27	2.81	3.63	3.65	3.61
TSP	0.36	0.45	0.58	0.58	0.58

SOURCE: 1

If the MRTS system is introduced in Delhi (see Table 4) and caters to 25 per cent of the total demand by 2010, 2.4 per cent of the total energy demand in the passenger transport sector will be in the form of electricity. Compared to the first scenario, CO, HC, NO_X, TSP and SO_2 emissions would be reduced by 25 per cent, and lead emissions will come down by 23 per cent.

But if scenarios 2, 3 and 4 are implemented as a totality, in phases (1994-95, 2000-01 and 2004-05 respectively), a maximum energy conservation scenario would emerge, with a net saving of as much as 50 per cent by 2009-10, as compared to the first scenario. There would be significant reductions in emissions, particularly in the case of TSP which would reduce by 55 per cent by 2009-10. CO and lead levels by this period would lessen by 50 per cent, HC by 49 per cent, NO_X by 53 per cent and SO_2 by 54 per cent (see Table 5).

The study found that if present trends were allowed to continue, fuel consumption would more than double by 2009-10. The pollution levels of different pollutants would also double by the year 2009-10. Increasing the average vehicle speed from the present 20 km/hr to 40 km/hr via improved road conditions, would reduce the demand for gasoline by 17 per cent and the demand for diesel by 42 per cent by the year 2009-10.

Table 5 Estimated emissions in case of a maximum conservation (in thousand tonnes)

Pollutants	1990–91	1994–94	2000–01	2004–05	2009–10
CO	179.59	168.73	192.43	193.71	191.62
HC	73.00	70.10	79.89	80.42	79.55
Pb	0.10	0.10	0.11	0.11	0.11
NO_X	16.12	12.70	16.06	16.17	15.99
SO_2	2.27	1.74	2.26	2.28	2.25
TSP	0.36	0.27	0.36	0.36	0.35

SOURCE: 1

Strategic planning

Concepts adopted by other countries to control vehicular miles travelled

Some of the strategies resorted to by other countries to control vehicular miles travelled, through concepts such as carpooling, increased use of mass transit, parking restrictions and gas rationing include:

- **Policies to induce shifts to more efficient transportation modes**: These policies act to reduce transportation energy consumption and emissions per mile. As part of the efforts to promote this policy, disincentives such as increased parking charges were introduced.
- **Policies to increase the load factor of existing vehicle fleets**: Car-pools; van-pools.
- **Policies to shift time of peak travel demand occurrence**: Four-day work weeks; staggered work hours; general traffic circulation improvements, such as synchronised signals.
- **Policies to reduce travel demand**: Redistribution of urban activities; substitution of transportation with communication.

transport in India — its financial viability. Calcutta started operating a part of its MRTS in the 1980s, but the project has run into financial trouble because of subsidies on ticket prices, and is expected to incur losses of Rs 15 crore this year. In Madras, the project was expected to cater to one lakh passengers a day, but only 1,500 passengers have taken to it. The Indian Railways anticipates similar problems in Delhi, and is "afraid of losing face like organisations like DTC, which are forced to give subsidies and end up bankrupt," as Ranganathan says.

But Ranganathan feels that the projects could easily be made to stand on their own feet, either through the 'value capture' of land that becomes prime commercial space along the MRTS track, or through participation from the private sector.

There have been several objections to the introduction of MRTS in Delhi, with planners claiming that the money would be better spent on developing the National Capital Territory Region (NCTR), and the system would work against the principle of decentralisation. But the electricity-run MRTS would

Table 3.4.6 Vehicle occupancy in Indian metros (persons/vehicle)

Metropolitan cities	Two-wheelers	Cars/jeeps	Taxis	Three-wheelers	Buses
Mumbai	1.6	2.6	2	1.8	42
Calcutta	1.6	2.6	2	1.8	40
Delhi	1.7	2.4	2	1.8	47
Madras	1.6	2.6	2	1.8	37
Hyderabad	1.6	2.6	2	2.2	38
Bangalore	1.6	2.6	2	1.8	42
Ahmedabad	1.4	2.3	2	1.6	42

SOURCE: 3

certainly provide a low-polluting alternative to private transport, or even buses, and reduce emission levels considerably.

But even if MRTS is effectively implemented in Indian cities in the near future and is efficient, a large percentage of the population will continue to use private transport. This calls for efficient traffic management systems, and a more aggressive implementation of concepts like car-pooling to increase occupancy (see Table 3.4.6), and reducing trip lengths and frequency. Besides reduced emissions, these concepts will also ensure road safety, reduce congestion, and cut national spending on fuel. Preventing congestion has the added benefit of reducing time wasted due to traffic jams. A recent study reveals that congested roads costs the US $300 billion annually.

Congestion problems are maximum during peak hours, between 9 and 10 in the mornings and 5 and 6 in the evenings. Some countries have implemented a system of staggered work hours to avoid jams. Many countries have also worked out a system of road pricing, whereby low occupancy vehicles pay a charge for entering congested areas during rush hours. The system encourages the use of public transport and shared private cars or taxis, and discourages avoidable journeys.[5]

These methods of controlling traffic growth seem unlikely to be implemented in India for a long time to come — not only because of the lack of political will, but also because not enough thought has gone into traffic management so far. Traffic management in India has been left to the traffic police, who have no real training in management and anticipating future problems. "Traffic planning is a function of the police only by accident," says Ranganathan. "In today's situation it is, in fact, a full-time job which needs qualified staff applying their minds to it. Decisions taken to improve the transport system so far are either simply buying time or covering up inadequacies."

With transport allotted the second highest budget after energy, the district administration should consider setting up a separate department of traffic planning to keep track of developments in traffic trends, feels Ranganathan.

Table 3.4.7 **Emission-speed relationship**

Speed (km/hr)	Average emission (gm/km/vehicle)		
	CO	HC	NO_X
10	33.02	4.47	2.53
25	21.20	2.60	2.17
50	9.80	1.30	2.13
75	6.40	0.93	2.24
100	7.83	0.86	2.97
125	11.04	0.87	4.15
150	13.97	0.92	6.07

Notes: Figures are valid only for petrol-driven cars
CO : carbon monoxide
HC : hydrocarbons
NO_X : nitrogen oxides

SOURCE: 9

Another disadvantage of having a branch of the regular police force in charge of traffic planning is that the deputy commissioner (traffic) is regularly transferred, and any insight gained into the problem is lost. The new officer will have to start all over again.

Traffic police departments in cities have evolved various methods to reduce traffic jams, but have met with little success. "There have been efforts to do better road network planning in the cities but the effort has not been commensurate with the need," says Ranganathan. Calcutta, for example, has sought to reduce traffic on its roads by prohibiting the entry of heavy freight vehicles into the city during the day, and introducing a one-way system in several places. In Delhi, the emphasis is towards segregating fast-and-slow moving traffic in congested areas like Chandni Chowk, and

Bicycles race ahead

...the cyclist must be encouraged

The continuing popularity of the bicycle as an inexpensive and reliable form of transport is reflected in the upward trend in world production figures of bicycles. While the world produced 111 million bicycles in 1994, these figures rose to an estimated 114 million in 1995.[1]

More than two-thirds of the bicycles in the world are produced in Asia. Although China is by far the world's largest manufacturer of bicycles, in recent years, India has emerged as a competitive exporter of bicycles, with shipments growing by more than 12 per cent in 1994.[1]

Table 1 **Bicycle use in Indian cities (1986)**

City	% of bicycles in traffic	% of bicycle trips
Ahmedabad	38	21
Pune	41	16
Kanpur	48	30
Lucknow	53	34
Coimbatore	43	15

SOURCE: 2

Trends in bicycle use differ widely from region to region. Several cities in Asia are increasingly hostile to bicycles. During the past three years, bicycles have been banned from the city centre in Jakarta, Shanghai and Dhaka, allegedly for fostering an image of backwardness and for clogging city streets. Also, economic prosperity has cut into the bicycle's popularity — in Vietnam, bicycle use has declined since the mid-1980s as use of motorcycles has picked up.[1]

In India, non-motorised vehicles like bicycles, cycle rickshaws and tongas are the predominant modes of transport in small and medium-size cities, particularly amongst the urban poor. For instance, in Delhi the bicycle caters to 40 per cent of the work trips, in the range of 2-8 km, among the low-income commuters. However, less than 10 per cent of the higher-income group commute by bicycles. On the other hand, in medium and small-size cities, bicycles are evenly distributed across all income groups.[2]

Government policies can be instrumental in promoting bicycle use. In the Netherlands, where bicycles account for upto half the trips in some cities, governments actively encourage cycling by providing safe and convenient cycle routes and through disincentives to drive: civil servants are now required to make all official trips by bus, rail or bicycle.[1]

Bicycles are now included in transport planning at the national and international level. For the first time, World Bank is considering authorising lending for projects on non-motorised transport. With increased acceptance and promotion of the bicycle at various levels, its full potential moves closer to realisation.[1]

AMIT SHANKER / CSE

In Delhi, the bicycle caters to 40 per cent of the work trips among the low-income commuters

Growing by leaps and bounds

Should the automobile boom in India be encouraged?

It was not just a coincidence that T G Venkataraman, Union Minister for Surface Transport, was the chief guest at the 1996 annual session of the Association of Indian Automobile Manufacturers (AIAM). With India's automobile industry growing at breakneck speed after passenger cars were delicensed in 1993, there is only one possible hurdle in its way to doubling its capacity from four million units in 1995 to eight million by the turn of the century — the lack of road infrastructure.

Foreign investors see a lot of potential in the car-starved Indian market. But forecasters warn that given the existing road infrastructure, India cannot accomodate the present rate of growth. Even the AIAM annual session held in New Delhi on 24 September, 1996 laid emphasis on developing more roads. In his welcome address, AIAM president Brijmohan Lall came straight to the point. "(We) welcome you

Table 1 **Projected capacity and investments in the automobile industry**

	Existing (1995)	Fresh (by 2000)	Total (by 2000)
Production capacity (in million)			
Cars and commercial vehicles	0.6	1.8-2.2	2.4-2.8
Two-wheelers and three-wheelers	3.2	1.7-2.0	4.9-5.2
Total	3.8	3.5-4.2	7.3-8.0
Investments (Rs crore)			
Cars and commercial vehicles	6,000	20,000-28,000	26,000-34,000
Two-wheelers and three-wheelers	2,000	2,000-4,200	4,000-6,000
Total	8,000	22,000-32,000	30,000-40,000

SOURCE: 1

reviewing the system of traffic signals in the city. This includes reducing the number of vehicles to the minimum required, and introducing a new system.

"We are working on a system to synchronise the traffic lights in the city," says Ujjwal Mishra, DCP (traffic). The system was tried in Connaught Place, but has so far proved to be a failure. But the volume of traffic in Connaught Place has been considerably reduced by earmarking specific entry and exit points, preventing parking in the outer circle, and no red lights in the inner circle. Mishra claims that the experiment has been successful, though it was initially opposed by the traders in the area. They felt that customers would be discouraged from coming to their shops if they could not drive their vehicles right up to the doorstep. But experiments abroad have shown that the atmosphere is more conducive to shopping when people can walk around without traffic milling around and pumping pollution into the air.

In fact, Ranganathan suggests that there should be total restrictions on vehicle entry in crowded business centres like Connaught Place, after parking spaces have been provided outside the area, with

here and hope that with you at the helm of one of the most important ministries, we will, in all likelihood, move into the 21st century with an infrastructure development agenda." He concluded by asking the minister to declare 1997 as the 'Year of development of roads'.

But should India really go all out to provide more roads for luxury vehicles? True, India's road network could do with improvements but expanding it without careful consideration may only feed an insatiable appetite. Many countries have already come to realise that curbing growth in personalised vehicles, rather than passively providing the infrastructure for uncontrolled growth, is a better strategy for controlling pollution.

Table 2 Projections of Indian car market size in 2000 AD

Research agencies	No. of vehicles
DRI/McGraw-Hill	432,000
AIAM	850,000
DCM-Daewoo	800,000
Maruti	700,000
Hindustan Motors	1,000,000
McKinsey	833,000
INFAC	580,000
Morgan Stanley	576,000
Planned car production	1,300,000

SOURCE: 2

The automobile industry is already growing at a very fast pace. After it was completely deregulated in 1993, when passenger cars were delicensed, the sector registered a 26 per cent growth in the financial year 1995-96. As a recent automobile survey pointed out, *never before in the history of the automobile industry have so many manufacturers come to one country in such a short period of time, and the commercial and passenger car sector is attracting the maximum investment.*

Projections of the car demand for 1995-96 were off the mark by as much as 83,755 cars. AIAM had predicted a sale of 261,600 cars during the year, but the market went up by more than 30 per cent. Estimates about market size for the year 200 vary. While AIAM forecasts a demand of 8.5 lakh cars, estimates by other market research agencies and automobile manufacturers vary from as high as a million to DRI/McGraw-Hill's 432,000 (see Table).[2]

The point is, do our cities have the space needed to expand the road network and accomodate these cars? And without a proper pollution control strategy in place, how are we going to deal with the increase in pollution?

shuttle services between the parking areas and shops.

Controlling the number of vehicles on the road and reducing them to the bare minimum will also have the additional benefit of increasing the average speed of vehicles. Carbon monoxide (CO) and hydrocarbon (HC) emissions are considerably higher from slow moving petrol-driven cars, while slow-moving diesel vehicles emit more HC (see Table 3.4.7). Emissions also increase when the vehicle speed goes over a certain limit. So for minimum emissions, it is important for vehicles to maintain a certain speed, neither too fast nor too slow.

While clean automobile technology and stringent emission rules will retard the air pollution rate caused by vehicular emissions, clearly the only way to keep pollution within limits is to keep down the number of vehicles on the road and adopt measures which discourage their use. This calls for an altogether different perspective to the pollution problem in India, where the growing number of vehicles has been more or less taken for granted, and traffic management problems are dealt with as separate, as having little to do with the problem of vehicular emissions.

According to eminent heart surgeon Naresh Trehan, the rate of respiratory diseases in Delhi is 12 times more than the national average. As the rate of asthma cases amongst children increases, vehicular pollution is debilitating our future — nearly 12 per cent of Delhi's school children are asthmatics.

◆

In Delhi, no figures are available on ozone levels in the city. The chairperson of the Central Pollution Control Board believes that ozone is not a health hazard. But the head of the cardiorespiratory department of Delhi's Patel Chest Institute asserts that ozone is the most harmful of all primary and secondary vehicular emissions.

◆

In Mumbai, the rising number of cardiovascular deaths is attributed to vehicular pollution — the city has half the taxis in the country and a fifth of all private vehicles.

◆

80-90 per cent of lead in ambient air is attributed to combustion of leaded petrol. Since children inhale a proportionally higher volume of air than adults, their lung deposit rate is about 2.7 times more than that of adults. Infants and children below five are particularly sensitive to lead exposure because of its potential effect on neurological development.

◆

Unleaded fuel in India has very high levels of benzene which is added to enhance the anti-knocking properties of fuel. But benzene is a definite carcinogen and alongwith lung cancer and leukaemia, it causes damage to the central nervous system, and leads to hematological and immunological effects.

Chapter IV

Breathless

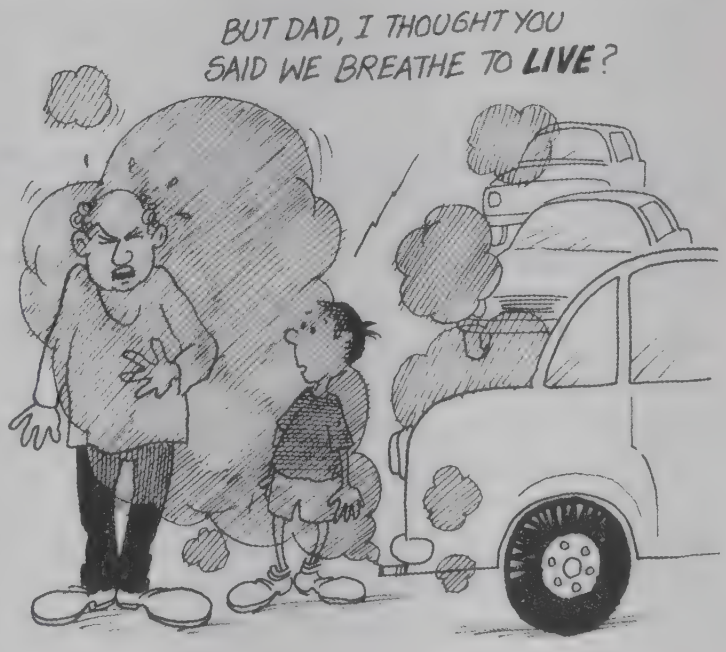
Naresh Trehan, heart surgeon and executive director, Escorts Heart Institute and Research Centre, New Delhi, has an easy way of identifying his patients from Delhi. "Patients from outside Delhi have pink lungs — but residents of this city have black lungs," he says.

While rueing the fact that few studies have been done to pinpoint the health effects of vehicular pollution, he adds that evidence of its harmful effects are all around us, and we don't need health studies to confirm that the situation needs urgent action.

"More and more people are reporting sick in offices every day, complaining of some respiratory disorder or the other," he says. "People who move out of Delhi to farms in the suburbs begin to feel better in just a few weeks. This is the layman's perception of what we doctors know to be reduced immunity because of vehicular pollution."

Trehan points out that the rate of respiratory diseases in Delhi is 12 times higher than the national average, thanks to the slow but steady assault of pollutants. According to him, vehicular pollution is debilitating our future, as the rate of asthma cases among children increases. "Asthma is a lifetime affliction, we're heading towards a generation of asthmatics," he says.

Trehan's hypothesis is confirmed by a study done by S K Chabbra, head of the cardiorespiratory department of the Patel Chest Institute, Delhi. Chabbra collected data from 10,000 school children in Delhi as part of a project started in October 1994. He found that the prevalence of asthma among the children was 11-12 per cent. "This figure does not take into account cases of 'cumulative asthma', or children who showed symptoms of asthma at some point in the past. If they are included, the figure goes up to 16-17 per cent — translated into actual figures, this means at least 2.5 lakh children in Delhi have, or had, asthma," he says.



Though Chabbra has no past data to compare his results, studies in Australia and the US, according to him had reported a prevalence of 5-7 per cent asthma cases among school children two decades ago. This figure has now gone up to 15-20 per cent, which is similar to the Indian study.

Chabbra is working on two other projects — a cross-sectional and longitudinal study on traffic policemen, and a recently initiated study on morbidity in Delhi due

Death by breathing

A study carried out in Bombay on the rising number of cardiovascular deaths

According to a study carried out in 1976 under S R Kamat of the chest and medicine department of KEM Hospital, Mumbai, the rising number of cardiovascular deaths in Mumbai is attributed to traffic congestions in certain parts — Mumbai has half the taxis in the country and a fifth of all private vehicles.

The study carefully looked into the link between carbon monoxide pollution, caused by cars and trucks, and ischaemic heart disease in the community living at a busy road junction, Lalbaug, in the heart of the central district. The study found no direct causal relationship, though the vehicular exhaust did contain sulphur dioxide (SO_2) and nitrogen dioxide (NO_2), which affect breathing.

Nevertheless, the survey recommended that traffic junctions should be properly designed for smooth flow and flyovers built at some distance from residential buildings — a timely suggestion since the Draft Development Plan for Greater Mumbai (1981-2001) talks of 23 new flyovers for the metropolis.

to air pollution. While the cross-sectional study tested the bronchial reactivity of traffic policemen who have been on the field for about three years, the longitudinal study is keeping a record of policemen right after they join the force to monitor their health over three years. So far, he has found that exposure to vehicular pollution definitely increases bronchial reactivity, making them more susceptible to lung disorders.

Besides the lack of previous health data, Chabbra was also dogged by the lack of pollution data in the course of his work. He admits that his study on morbidity in Delhi will be limited by the fact that there are no figures available for ozone, benzene and polycyclic aromatic hydrocarbons (PAH) levels in the city. Contrary to CPCB chairperson Biswas' belief that ozone is not a health hazard (see Annexure 2), Chabbra asserts that ozone is probably the most harmful of all 'primary' and 'secondary' vehicular emissions. This is confirmed by a recent study released by the American Lung Association, which focussed on 3,091 non-smoking Seventh Day Adventists (Christian sect) living in California between 1977 and 1992. The study found that ozone and particulate matter were largely responsible for the 106 cases of asthma which developed during that period. The project was conducted by researchers at the Loma Linda University and the University of Arizona.

Very few studies address vehicular pollution and health in India. But a World Health Organisation (WHO) report gives fairly detailed descriptions of how the body reacts to individual pollutants.

Emitting ill-health

Vehicular emissions, like carbon monoxide (CO), nitrogen oxides (NO_X) unburnt hydrocarbons, ozone and other photochemical oxidants, suspended particulate matter (SPM), sulphur dioxide (SO_2) and volatile organic compounds (VOCs), result either from primary emissions or from atmospheric transformations. These pollutants and their derivatives can cause adverse health effects by interacting with, and impairing, molecules crucial to biochemical or physiological processes of the human body.

Three factors condition the risk of toxic injury from these compounds — their chemical and physical properties, the amount of the material that reaches critical tissue sites, and the responsiveness of these sites to the compounds. Pollutant effects may also vary across population groups. The very young and the elderly are particularly susceptible to deleterious effects, while persons with asthma and pre-

existing respiratory and cardiac diseases may experience aggravated symptoms upon exposure. "We are not certain that Delhi's pollution is creating new asthmatics but without a doubt, those who already have it are very badly hit by Delhi's pollution. Attacks are getting more frequent and much more severe," says Sachdeva, who is with the pediatrics department of Maulana Azad Medical College. "Asthma in children has decidedly gone up and it is on the rise among infants."

Pollutants from vehicles can be divided into three types based on their effect on the human body — NO_X, ozone and other photochemical oxidants, sulphur oxides and SPM, which exert irritant inflammatory effects on the respiratory organs; CO and lead, which produce toxic systemic effects; and carcinogenic substances like benzene, PAH and aldehydes.

Pollutants which irritate and inflame

Nitrogen oxides: Oxides of nitrogen are formed chiefly during combustion of fuel in motor vehicles and power stations. Practically all oxides of nitrogen derived from combustion are discharged as nitric oxide (NO) and gradually convert to nitrogen dioxide (NO_2) in the atmosphere. Together with atmospheric oxygen and ultraviolet radiation, NO_2 participates in a series of reactions that ultimately leads to the formation of photochemical smog. Of the oxides of nitrogen existing in ambient air, NO_2 is the most toxic.

About 80-90 per cent NO_2 inhaled is easily absorbed into the mucosa of the respiratory tract, although this proportion varies according to nasal or oral breathing. Because NO_2 is not very soluble in aqueous surfaces, the upper airways in humans retain only small amounts of the gas. Nitric and nitrous acids or their salts can be detected in blood and urine after exposure to NO_2. The spectrum of pathological effects on the lung, resulting from high occupational exposure to NO, range from mild inflammatory response to bronchitis, bronchopneumonia, and acute pulmonary oedema at high concentrations.

WHO guidelines stipulate that levels of exposure to NO_2 should not exceed 400 $\mu g/m^3$ (0.21 ppm) for 1 hour and 150 $\mu g/m^3$ (0.08 ppm) for 24 hours.

Ozone: Ozone is the principal ingredient of smog, and its primary target organ is the lung. Ozone exposure produces cellular and structural changes, the overall effect of which is a decrease in the ability of the lung to perform normal functions. Ciliated cells, which clear the airway of inhaled foreign material, are the most sensitive to ozone exposure. According to a survey of health studies of petrochemical air pollution in Japan by M Imai *et al*,[3] studies carried out in Japan showed significant increase in symptoms during periods of

Table 4.1 Lowest levels of SO_2 and TSP that effect health (in $\mu g/m^3$)

Effect	24-hour exposure			Annual exposure		
	SO_2	Smoke	TSP	SO_2	Smoke	TSP
Excess mortality	500	500		100	100	
Increased acute respiratory morbidity (adults), symptoms or illness	250	250				
Decreased lung function (children)			180			180

Notes: $\mu g/m^3$: in micrograms per cubic metre SO_2 : sulphur dioxide
TSP : total suspended particulate matter

SOURCE: 1

Cost of living

Polluted air results in huge monetary losses

Clean up the air in Indian cities, and over 40,000 premature deaths, 17 million respiratory hospital admissions and 1.2 billion restricted activity days can be avoided, says a study carried out by Carter Brandon and Kirsten Hommann of the Asia Environment Division of the World Bank. *The Cost of Inaction: Valuing the Economy-wide Cost of Environmental Degradation In India* puts down the annual number of deaths due to air pollution at 7,500 (19 per cent) in Delhi, 5,700 (14 per cent) in Calcutta and 4,500 (11 per cent) in Bombay.

According to the study, air pollution exceeds WHO recommendations in most of the 23 Indian cities with a population of over one million. The annual level of total suspended particulates in six Indian cities — Bombay, Calcutta, Delhi, Ahmedabad, Kanpur and Nagpur — is at least three times higher than the World Health Organisation(WHO) standard. In fact, in Delhi, Kanpur and Calcutta, it is five times

Table 1 Health costs due to ambient air pollution levels exceeding WHO guidelines in Indian cities

Nature of effect	No. of cases	Cost valuation (US $millions)
Premature deaths	40,351	170-1,615
Hospital admissions and sickness requiring medical treatment	19,800,000	25-50
Minor sicknesses (including restricted activity days and respiratory symptom days)	1,201,300,000	322-437
Total	—	517-2,102

SOURCE: 1

higher than the WHO standard.

Brandon and Homman worked out the value for a life in India at US $4,208 to $40,017 (Rs 147,280 to 1,400,595) using the US figure ($1.6-8.5 million/life) and the ratio of national per capita incomes of the two countries. Assuming that each person dying prematurely of air pollution would have lived for another 10 years, the monetary loss due to 40,000 premature deaths is between US $170 million (Rs 595 crore) and US $1,615 million (Rs 5,652.5 crore).

PM10s (particulate matter less than 10 microns in size) and sulphur dioxide are responsible for over 95 per cent of the health damages in Indian cities, while lead levels in cities such as Calcutta, Bombay and Delhi contribute to the remaining 5 per cent. The report estimates that the impact of current ambient lead levels in 10 cities alone account for 200,000 hospitalisation cases per year, and 0.5 million lost IQ (intelligence quotient) points in children. The monetary value of these impacts are $7 (Rs 2.45 crore) to $18 million (Rs 63 crore) per year in foregone life earnings. The report also adds that these estimates are likely to be low due to incomplete data on ambient lead levels.

The authors warn that ozone, lead, and hydrocarbons levels are likely to rise quickly with rapid growth in urban vehicle population.

increased ambient ozone exposure.

The symptoms include eye, nose and throat irritation, cough, dryness in the throat, thoracic pain, increased mucous production, tightness in the chest, substernal pain, lassitude, malaise and nausea. The long-term effects of ozone are still unclear but there is good reason to believe that continued exposure could lead to chronic impairment of lung development and function.

WHO guidelines stipulate that levels of exposure to ozone should not exceed 150-200 $\mu g/m^3$ (0.076-0.1 ppm) for one hour, and 100-120 $\mu g/m^3$ (0.05-0.06 ppm) for eight hours.

Besides causing health problems, ozone pollution contributes to the greenhouse problem and adversely effects crops and vegetation. The gas has reduced crop productivity in the US, and killed Ponderosa and Jeffrey pines in California.[4]

Sulphur dioxide and particulate matter: Inhaled SO_2 is highly soluble in aqueous surfaces of the respiratory tract. It is absorbed by the nose and the upper airways, where it exerts an irritant effect; and a little reaches the lungs. High concentrations can cause laryngo-tracheal and pulmonary oedema. From the respiratory tract, SO_2 enters the blood. The deposition of particulate matter depends mainly on the breathing pattern and the particle size. Larger particles are deposited in the exothoracic part of the respiratory tract, while particles 5-10 μm in size are deposited in proximity to the fine airways with normal nasal breathing. Breathing through the mouth causes an increase in the proportion of tracheobronchial and pulmonary deposition.

During the first half of this century, incidents of marked air stagnation have resulted in well-documented excess mortality in areas where fossil fuel combustion produced very high levels of SO_2 and TSP. In one notable episode, in Donora, Pennsylvania in October 1948, 43 per cent of the population of approximately 10,000 were adversely affected. A similar event occurred later in London, where concentrations of SO_2 and smoke rose above 500 $\mu g/m^3$. It mainly affected those with pre-existing heart and

Table 4.2 **Effects of vehicular pollutants on humans**

Substance	Health effects
CO (from gasoline cars, 2-wheelers, 3-wheelers)	Fatal in large doses; aggravates heart disorders; effects central nervous system; impairs oxygen carrying capacity of blood
NO_X (from diesel vehicles)	Irritation of respiratory tract
Ozone	Eye, nose and throat irritation; risk to asthmatics, children and those involved in heavy exercise
Lead (from petrol vehicles)	Extremely toxic: affects nervous system and blood; can impair mental development of children; causes hypertension
HC (mainly from 2-wheelers and 3-wheelers)	Drowsiness, eye irritation, coughing
Benzene	Carcinogenic
Aldehydes	Irritation of eyes, nose and throat, sneezing, coughing, nausea, breathing difficulties; carcinogenic in animals
PAH (from diesel vehicles)	Carcinogenic

Notes: CO : carbon monoxide; NO_X : nitrogen oxides; HC : hydrocarbons; PAH : polycyclic aromatic hydrocarbons

SOURCE: 2

Occupational hazards

Effects of traffic pollution on the health of Delhi traffic policemen

The Central Road Research Institute (CRRI), Delhi, carried out a study on the effects of road traffic pollution on the health of Delhi traffic policemen in 1991 under S M Sarin. Traffic policemen posted at intersections and roadside belong to the high-risk, occupationally exposed group, and perhaps suffer most the ill-health effects resulting from increasing congestion and excessive pollution build-up in the roadside environment. The study covered workers in the field (exposed group) and in an office environment (control group).[1]

Table 1 Incidence of lung disorders

Group	X-ray report	
	Abnormal (%)	Normal (%)
Lesser exposed	10.3	89.7
Greater exposed	27.3	72.7
Exposed group	18.1	81.9
Control group	16.3	83.7

SOURCE: 1

Incidence of lung disorders

The study (see Table 1) revealed that a higher proportion of the exposed group (18 per cent) suffered from lung disorders such as tuberculosis, than the control group subjects (16 per cent). However, among those exposed for more than eight years to busy traffic conditions, 27 per cent exhibited abnormalities as against 10 per cent cases among lesser exposed subjects.

Lung vital capacity

Evaluation of lung functions status was made through measurement of forced vital capacity (FVC) of the subjects. Test results show that one-third of the exposed group, as against only one-fourth of the control group, possessed a lower vital capacity (3.5 litres). Of those with longer years of exposure, 40 per cent had a lower than normal vital capacity while about 40 per cent of the smokers within the

Table 2 Assessment of subjects to adverse traffic effects

Problem experienced	Lesser exposed	Greater exposed	Exposed	Control
Eye irritation	89.7	93.9	91.7	27.9
Throat problems	76.9	93.9	84.7	14.4
Respiratory discomfort	59.0	45.5	55.5	4.7
Discomfort with smoke	97.4	97.0	97.2	76.7
Skin ailment	20.5	27.3	25.0	7.0
Effect on hearing	51.3	57.6	54.2	7.0
Annoyance with noise	89.7	90.9	90.3	65.1
Other problems	89.7	90.9	90.3	34.9

SOURCE: 1

ARVIND YADAV / CSE

Traffic policemen posted at intersections and roadsides are perhaps the most affected by the increasing congestion and excessive pollution build up

exposed group suffered from such disorder.

Another parameter related to the lung function is forced expiratory volume in one second (FEVI). It was noted that as against 60 per cent of those in the exposed group, only 21 per cent in the control group had a lower FEVI (below 71 per cent) than the normal of these in the more exposed group; 64 per cent showed a lower value than the normal.

Carboxyhaemoglobin in the system (COHb)

Excessive COHb results in lowering the oxygen carrying capacity of blood. COHb over 0.5 per cent is considered abnormal. The CRRI found that 98 per cent of those in the exposed group had excessive COHb as compared to only 37 per cent of the control group subjects.

Breath carbon monoxide (COBr)

CO in breath is expressed as parts per million (ppm). A value of greater than and equal to 4 ppm is considered as abnormal. In the control group, nearly 35 per cent of the subjects were found to be abnormal, whereas all the subjects (100 per cent) in the exposed group were thus affected.

lung diseases, the elderly, and children under five.

Environment Protection Act standards for ambient SO_2 are a maximum annual average of 80 $\mu g/m^3$ (0.03 ppm) and a 24-hour average of 365 $\mu g/m^3$ (0.14 ppm). For particulate matter, annual average is 75 $\mu g/m^3$ while the 24-hours average is 260 $\mu g/m^3$.

Pollutants that produce toxic systemic effects

Carbon monoxide: CO is quickly absorbed by the lungs and carried in the blood, which leads to a decreased work capacity under maximal exercise conditions. In the blood it binds to the haemoglobin, forming carboxyhaemoglobin (COHb), and thereby impairs the oxygen-carrying capacity of blood. The affinity of haemoglobin for CO is about 240 times that of oxygen. The main factors conditioning the uptake of CO are its concentration in inhaled air, endogenous production of CO, the intensity of physical effort, body size, condition of the lungs, and the barometric pressure.

The main effect of CO is the decrease of oxygen transport to the tissues. Organs like the heart, the central nervous system, and the foetus, which need large oxygen supply, are mainly at risk. Four types of adverse health effects are reported to be associated with CO exposure: neuro-behavioural effects, cardiovascular effects, fibrinolysis effects, and prenatal effects. Chronic angina patients seem to be the most sensitive to CO exposure.

The classic symptoms of CO poisoning are headache and dizziness (when COHb levels are between 10 and 30 per cent), and severe headaches, cardiovascular symptoms and malaise (when it is above 30 per cent). At above 40 per cent, there is considerable risk of coma and death.

According to WHO, in the absence of CO exposure, the normal COHb concentrations are approximately 0.5 per cent, though one-pack-per-day cigarette smokers may achieve COHb saturation of 4-7 per cent. To prevent COHb levels exceeding 2.5-3 per cent in non-smoking populations, WHO proposes the following guidelines: a maximum permitted exposure of 100 mg/m^3 for 15 minutes; 60 mg/m^3 (50 ppm) for 30 minutes; 30 mg/m^3 (25 ppm) for an hour; and 10 mg/m^3 (9 ppm) for 8 hours of exposure. Carbon dioxide also contributes to smog formation and build-up of methane.

Lead: Alkyl lead additives in motor fuels account for a major part of all inorganic lead emissions. An estimated 80-90 per cent of lead in ambient air is attributed to combustion of leaded petrol. About 1 per cent of the lead in petrol is emitted unchanged as tetra alkyl lead (organic lead). There is, in addition, some evaporation of organic lead from the engine and fuel tank.

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Since children inhale a higher proportion of air than adults their lung deposition rate of lead can be 2.7 times higher

Most of the lead in ambient air is from fine particles. Young children inhale proportionately higher daily air volume per unit measure (weight, body area) than adults, and so they have a lung deposition rate of lead that can be up to 2.7 times higher than adults on a unit-body mass basis. The proportion of lead absorbed by the gastrointestinal tract is about 10 to 15 per cent in adults, whereas levels of 40-50 per cent have

been reported in children. Exposure to high concentrations of lead may lead to functional disorders of the gastrointestinal tract; a common sign of acute poisoning is colic. Lead may also damage the kidneys. Fasting, diets with low levels of calcium and vitamin D, and iron and zinc increase lead absorption.

The non-excreted fraction of absorbed lead is distributed amongst the blood, soft tissues and mineralising tissues such as bones and teeth. About 95 per cent of lead body-burden in adults is located in the bones, compared to 70 per cent in children. Lead is absorbed rapidly and nearly completely by the lungs. Absorption through the skin is also important. Tetra alkyl lead is metabolized in the liver and other tissues to tri alkyl lead, known to be the most toxic metabolite.

Infants and children below five are particularly sensitive to lead exposure because of its potential effect on neurological development. Prenatal exposure to lead, which is transported to the foetus through the placenta, produces toxic effects on the human foetus including reductions in gestational age, birthweight, and mental development. These effects occur at relatively low blood lead levels, as low as 100-150 µg/l, and possibly lower. The WHO guideline value for long-term exposure to lead in the air is 0.5-1.0 $\mu g/m^3$.

Pollutants with potential carcinogenic effect

Benzene: Benzene is a constituent of crude oil. When manufacturing unleaded fuel, benzene is added or maintained at higher levels to increase the octane number of fuel and enhance its 'anti-knocking' properties. The main sources of benzene emissions are motor vehicles and evaporation losses during handling, distribution and storage.

About 50 per cent of the benzene inhaled by the body is absorbed. Due to its high liposolubility, benzene is mainly distributed to tissues rich in fat, such as adipose tissue and bone marrow.

The toxic effects of benzene in humans following inhalation include damage to the central nervous system, hematological and immunological effects. High levels cause inflammation of the respiratory tract and hemorrhaging of the lungs, while acute poisoning can cause death. Benzene is also a known human carcinogen classified as Group 1[5] (definite carcinogen) by the International Agency for Cancer Research (IARC), and causes lung cancer and leukaemia. There is no safe level for airborne benzene.

Polycyclic aromatic hydrocarbons: Polycyclic aromatic hydrocarbons (PAH) are a group of chemicals formed during incomplete combustion of wood and fuel. Exhaust from diesel engines, particularly, contains high concentrations of particulate-bearing PAH.

PAH, known to be mutagenic and carcinogenic, are absorbed in the gut and lungs. Studies among workers exposed to automotive emissions indicated that truck drivers or delivery men had a 50 per cent greater likelihood of being afflicted with bladder cancer. There is, once again, no safe level of PAH.

Aldehydes: Aldehydes are absorbed by the respiratory and gastrointestinal tract. The WHO standard is $0.1 mg/m^3$ (0.083 ppm) for a 30 minute average. Effects of aldehydes include ocular and olfactory irritation, irritation of the mucous membranes and alteration in respiration, coughing, nausea, asthma, dermic allergy and dyspnea. Formaldehyde has been classified as possibly carcinogenic to humans.

Rani Kumar, department of anatomy and history of medicine, AIIMS, Delhi, had submitted a report *Ambient Air Quality Monitoring in Relation to Human Health in Metros of India — Delhi*, to the Central Pollution Control Board. According to the study, a clear link between pollution levels and human health could not be established. Far too many factors make it difficult to single out any one particular reason for deteriorating health standards. But whatever be the results, there is a definite trend towards impairment of health of people due to rising pollution levels, be it air, water or noise pollution.

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According to industrialist Rahul Bajaj, his highly polluting two-wheelers are providing mobility to the people and nothing can take place without a trade-off, without a sacrifice. But do the people know that they are trading something as precious as their lives for something of far less consequence like mobility? Does this choice even have to be made?

◆

The government must adopt a harsher stand towards the automobile industry and the latter must stop whining every time it is asked to produce less polluting vehicles and show a little more initiative in investing in clean technology.

◆

No more proof is needed of the fact that vehicular pollution is a health hazard. But the basis of any standard setting exercise or awareness campaign has to be based on a clear picture of the health threats.

◆

Providing clean fuel is a sure and immediate way of reducing vehicular pollution. But so far, the Central government has done almost nothing to ensure quality from its own public sector refineries.

◆

Indian roads are already very crowded and there is very little space for more vehicles in the cities.The government must review its policy of allowing unregulated traffic, especially private transport, and shift the emphasis to mass rapid transit systems.

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Chapter V

Our Right to Clean Air

Fining polluting cars will not clean the air in Indian cities. Nor will a fawning government which seeks the permission of industrialists before setting stringent standards for the automobile industry and indulges its public sector refineries. Good policy and sincere implementation, words which are now a cliché by virtue of topping the wish list of every socially-conscious Indian sick of disinterested and bungling politicians and bureaucrats, hold the key to clean air.

By cloaking the entire process of setting standards for the vehicle industry and by keeping people ignorant of the seriousness of the levels of pollution and its impact on people's health, it is very easy for policy makers and vehicle manufacturers to hide behind excuses. Central Pollution Control Board (CPCB) chairperson D K Biswas wants 'public pressure' to deal with vehicular pollution. But where will the pressure come from unless the government informs the people that the air they breathe is failing every standard in the book, that their cancers, eye infections, respiratory problems and cardiac disorders are because of an uncaring government and certain industrialists who rake in their money but don't care if they kill people in the process?

By keeping people ignorant of the seriousness of the levels of pollution and its impact on people's health, it is very easy for policy makers and vehicle manufacturers to hide behind excuses

Eminent industrialists like Rahul Bajaj gallantly claim they are 'providing mobility to people', and that 'nothing can take place without a sacrifice, without a trade-off'. But do people really know what exactly they are 'trading-off'? Do they know that they are in a bond with the devil, trading something as precious as their lives and health for something of far less consequence like mobility? Does a sick man even have the capacity to be mobile? Are they aware that they don't really need to make such a trade-off, that the government and industry can, if they get their act together, provide them mobility without killing them in the process?

The government of India and various state governments have played their part in the slow murder of India's urban citizens rather well so far — even managing to lay down the entire burden of guilt on the people. According to them, vehicular pollution will disappear, if only we would get their pollution under control certificates, and stop removing our catalytic convertors. Poppycock. Let them get the real criminals first.

Double failure

The problem of growing vehicular pollution arises out of governmental failure operating at two different levels. At its simplest level, it is a failure to deal with a complex and multifarious set of technical problems — emissions control technologies in manufactured vehicles, fuel quality, traffic planning, and

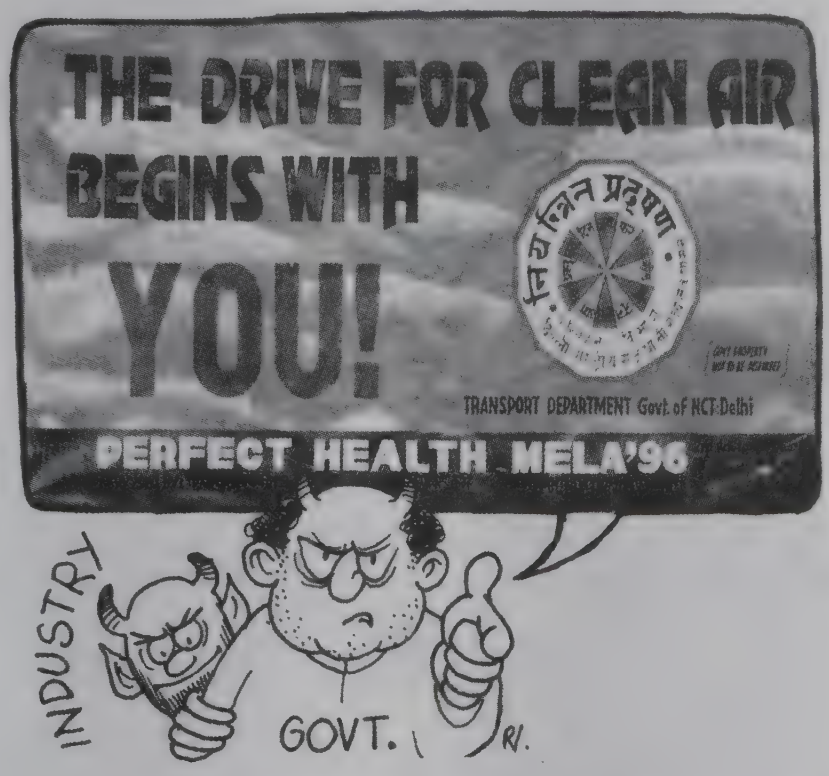
We demand...

Steps that should be taken immediately to improve the governance of vehicular pollution

- *A National Vehicular Pollution Prevention Commission should be set up* by the government of India, comprising not of ministers and bureaucrats who can destroy the working of any commission, but of technical and medical experts, industrialists and public-spirited environmentalists. Its exclusive purpose should be take stock of the state of air pollution and set future targets for air quality with steady improvements over time. As yet, the Ministry of Environment and Forests has not set any future targets for improvements in air quality. So nobody has any idea when the air is going to improve and by how much. The commission should recommend strategies to the government on how to meet these targets. It should also prepare a status report every year for the public on the state of air pollution, its health impacts and whether the air quality targets are being met, and if not, why not. This report should disclose the latest scientific knowledge about health threats posed by various pollutants and present epidemiological data on pollution-caused diseases. The commission must be legally and financially empowered to demand any relevant information from the government and industry and undertake studies on its own.
- *Similar Vehicular Pollution Control Commissions should be set up by state governments at the level of each mega-city facing serious air pollution problems.* These commissions will help to translate national-level analysis into city-specific analysis and promote local action.
- *All government documents related to decision-making on pollution control must be made available to the public on demand.*
- *All pollution control standards should be set on health-related criteria and not on the basis of what is technically feasible for the automotive or petroleum industry, as it is at present.* If the standards are too stringent, then clear decisions should be taken to incrementally improve the standards till they meet good health criteria.
- *The government must remove all subsidies and instead impose taxes on all types of transport fuel and vehicles, at levels which can bring some order into current traffic patterns — for instance, move people from private to public transport systems* — and the money so collected be used to support world-class pollution monitoring, research and development for emissions-control technology, and, if possible, development of an appropriate traffic infrastructure. The current fuel prices and road taxes, for instance, are only meant to mollycoddle private and public transport users by a dishonest government which does not inform them that this 'cheapness' and 'populism' comes at an enormous health cost of both the rich and poor in urban areas.
- *The government must immediately improve fuel quality because this is the only short-term measure which can improve air quality considerably.*
- *The government must take steps to control the total vehicle population in highly polluted cities and develop infrastructure for cyclists and pedestrians in polluted areas.* The pattern of car manufacture emerging after economic liberalisation must be constantly monitored for its impact on emissions and air quality of Indian cities and appropriate measures taken to tax models likely to cause pollution problems.
- *The government must ensure that the two-stroke technology is greatly improved to meet stringent emissions standards otherwise it must ban this technology.*

development of mass rapid transit systems.

But there is a larger failure that has lead to this failure to deal with technical issues, especially as India does not lack technologists or planners. This failure lies in the very governance systems that the country is saddled with. ***There are two things which are very essential for good governance, especially of issues that concern the people. Firstly, government decision-making processes should be transparent. Secondly, every effort should be made by the government to involve the stakeholders — the people, in this instance — by informing them about the threats and challenges they face and by providing them with the space necessary for participation in decision-making.*** Without public involvement, there cannot be any hope of behavioural change. And without transparency and involvement of stakeholders, there will be no pressure on the government to perform and deliver what is needed. In fact, there will be an accountability crisis, as indeed there is at the moment. (For our specific recommendations to improve the governance of vehicular pollution, see box 'We demand...')



We have drawn a list of recommendations aimed at reducing government failure at both the levels described above.

Throw out the kidgloves: dealing with the automobile industry

If it is business it wants, the automobile industry must deal straight. It must stop whining every time it is asked to produce less polluting vehicles, and show a little more initiative in investing in clean technology. The government should insist on the following:

- ***Given the current level of technology, the industry should commit itself to more stringent standards than what it has conceded as achievable so far.*** More so, since the benefits of the standards which are implemented now will take full effect only after older vehicles, which do not confirm to stringent standards, are phased out. If standards continue to be lenient, vehicles manufactured now will continue to pollute for another generation.
- ***Each automobile manufacturing firm should prepare a development plan for 10 years to indicate the technological changes it is planning to implement during that period to improve the emission efficiency of its vehicles.*** The plan should also include the research and development (R&D) objectives for reduction in emissions. Both manufacturing firms and automobile associations should publish an annual environmental performance statement.
- ***The automobile industry and independent research organisations should develop a centralised inventory of the world's best emission efficient technology for different models of vehicles, as a reference scale for comparison with Indian models.*** The inventory should grade the technology

PRADIP SAHA / CSE

The industry should either improve the two-stroke engine, used in most two- and three-wheelers in India, so that they meet the stringent emission norms or it must abandon the technology

according to indicators such as costs and commercial viability. This will allow for transparency in the system of technology adoption by the Indian automobile industry and will increase accountability.

- ***The government must review the wisdom of allowing so many foreign car manufacturers to enter into joint ventures in India.*** We simply do not have the traffic infrastructure to support so many vehicles. Besides, a selection criteria for sourcing technology has to be defined and made public to ensure that parameters on emission efficiency are included instead of only putting undue emphasis on the production of luxury products.
- ***The emission characteristics of each model of vehicle should be stated at the time of sale, to enable customers to make an environment friendly choice.***
- Industry should spend more money on developing emission free technology. The R&D cess collected from the industry should give priority to development of emission efficient technology.
- ***The industry should either develop two-stroke engines which meet stringent emission standards, or abandon the technology.***

Throw out the pollutants: improving the quality of fuel

Providing clean fuel is one sure and immediate way of reducing vehicular pollution. Put cleaner fuel into vehicles, and all of them immediately start emitting fewer pollutants. But will the Central government ever take stringent steps to ensure quality from its own public sector refineries? So far, it has done very little to indicate its seriousness. Asking the refineries to watch out for fuel quality now is like the police asking inmates of Tihar Jail to stay in prison after disbanding the force.

Some steps the government must take immediately to move towards cleaner fuel are:

- ***A reform programme to evolve a better monitoring structure for fuel quality control.*** Refineries have to own up responsibility for poor fuel quality, and take necessary steps to upgrade refining technology in the country.
- ***Fuel quality standards for parameters related to emission have to be included in the Environment Protection Act (EPA) in order to make them mandatory.*** A transparent monitoring body with public-spirited citizens has to be set up — so far, fuel quality is monitored by the refineries themselves.
- ***Refineries should move towards reformulating fuel to cut down on emissions.***
- ***Fuel pricing should be rationalised to discourage wasteful consumption.*** The diesel subsidy, for example, only benefits diesel vehicle manufacturers and their users.
- ***In the face of the unleaded fuel controversy, the after-effects of its introduction must be carefully monitored.***
- ***To improve parameters like octane number, which will enable adoption of superior automobile technology, the automobile and petroleum industries must work with each other.***
- ***To overcome adulteration problems, people must be made aware of the consequences, and better enforcement measures, like third party inspections (not by refinery officials) of petrol bunks, have to be put in place to dissuade adulteration by dealers.***
- ***Promote the use of non-polluting fuels like compressed natural gas.***
- ***Halt importation of dated refining technology.***
- ***Stop importing crude with a high sulphur content.*** The government cannot save foreign exchange at the cost of people's health.

Getting a clear picture: assessing air quality and setting emission standards

As Dr Naresh Trehan, the country's leading heart surgeon, and the study by World Bank staffers Carter Brandon and Kristan Homman point out, we no longer need proof of the fact that vehicular pollution is making people ill. But the basis of any standard setting exercise or awareness campaign has to be based on a clear picture of the situation as it is. Is it suspended particulate matter or sulphur dioxide that we need to deal with first? Are diesel vehicles the bigger culprits? The situation is bound to differ from place to place, as our three case studies show.

To work out an efficient strategy, we have to know what are the air pollutants in the first place. Towards this end, ***the Central and state pollution control boards must:***

- ***Create a more systematic approach to measure ambient air quality, with a source-wise inventory and local concentrations. The information should be collected on a regular basis, standardised for all urban centres, and reported publicly.***
- ***Start monitoring benzene and ground-level ozone levels in Indian cities.***
- ***Identify and grade polluting gases according to their harmful effects, including gases not being monitored so far, like benzene and ground-level ozone.***
- ***Monitor the local impact of air pollution on health by commissioning epidemiological studies and create a comprehensive database for toxic effects of each of the emission gases.***

We no longer need proof of the fact that vehicular pollution is making people ill. But the basis of any standard setting exercise or awareness campaign has to be based on a clear picture of the situation as it is

SUDHARAK OIWE

Indian roads are already crowded and there is very little space for more vehicles in our cities — the government must plan decongestion of roads to improve journey speed and thus reduce emissions

Picking out the death traps: inspection and maintenance of on-road vehicles

There are several vehicles on Indian roads which don't deserve to be there — thanks either to their outdated technology, or to careless maintenance. Left to themselves, they will continue to chug along for another decade, spewing out pollution and undoing any good that technology upgradation might do tomorrow. They have to go.

On the other hand, thanks to lack of proper maintenance, new cars can also pollute. The government has launched programmes to check car emissions. But there are several gaps which have to be plugged through feedback. For example, the number of checking centres must be increased. The government pleads that this is not possible because they don't have sufficient equipment. If that is the case, then appropriate taxes on the use of vehicles and the fines collected should be made to pay for more equipment.

To address the problems of vehicle maintenance, the government must:

- ***Tighten maintenance rules.*** So far they are extremely nebulous and do not deal with the problem of emissions from old vehicles. More comprehensive rules should be formulated to enforce a proper maintenance schedule for older vehicles.
- ***Devise maintenance rules according to the age of vehicles.*** The current rules only insist on a road worthiness certificates for vehicles older than 15 years. This should be reduced to five years, and the parameters for judging the road worthiness of a vehicle should be broadened to include emission criteria. Servicing stations should be informed of these and trained to test all vehicles coming to them for servicing accordingly.
- ***It is absolutely urgent to address the issue of scrapping very old and polluting vehicles from city roads to control vehicular population in the older age group category.***

- ***A package of fiscal incentives and disincentives should be developed for vehicle owners, to favour low-pollution vehicles.*** The tax load should be much higher for older and polluting vehicles and concessions should be granted if vehicle owners decide to replace older vehicles.
- ***Implement a maintenance scheme — for example, fining manufacturers of polluting vehicles to encourage them to provide maintenance services for vehicles even after sale.***

Ensuring a smooth flow: keeping traffic within limits

With a 25 per cent growth rate, the Indian automobile industry is one of the fastest growing industries in the world right now. But our roads are already crowded, and there is very little space for more vehicles in our cities. Given the present scenario, the government has to review the policy of allowing unregulated growth in the passenger car sector, in particular. The emphasis has to shift to public transport .

To manage existing traffic, the Central, state and city-level governments have to develop comprehensive traffic planning regulations to reduce emissions. Some measures which can be taken to reduce growth in the personalised transport sector and manage existing traffic are:

- ***Develop, where they don't exist, and improve, where they do, mass rapid transport systems to meet the travel demand in all the metros.***
- ***Plan decongestion of roads to improve journey speed and thus reduce emissions.***
- ***For traffic planning, concerned government agencies should do local mapping of traffic concentration and ambient air quality in the area to regulate and control movement of traffic. The number of vehicles allowed into congested areas should be controlled.***
- ***Develop incentives and disincentives to discourage use of personal vehicles.*** Some measures like introduction of road taxes to prevent vehicles into congested areas, and increasing parking fees can be implemented.
- ***Improve occupancy of both public transport and personal vehicles for optimum use of available road space by introducing high occupancy vehicle lanes/set up stands where people driving during commuting hours can pick up fellow commuters.*** Tax incentives could be given to personal vehicle owners if they increase their occupancy during work trips, or a system of disincentives for low-occupancy vehicles to congested areas be introduced.
- ***Rationalise and synchronise traffic signals to minimise stoppages and ensure smooth flow of traffic.***
- ***Develop infrastructure like pedestrian zones and lanes for non-motorised vehicles to discourage entry of motorised transport in congested areas.***
- ***Concerned institutions should develop urban plans to rationalize distances and bring residential and institutional zones in a city closer so that length of work trips are reduced. The test of such plans should be the proportion of trips made on foot and by bicycles.***
- ***Promote alternatives to rush hours*** (like staggered hours, telecommuting, etc).

Many of these recommendations are easy to implement — all they need is a government interested in dealing with vehicular pollution. Others are more difficult. But given a choice between health and mobility, we have no doubt that people will choose the former.

Readers, join in...

The above recommendations are neither comprehensive nor the ultimate. But they are being presented to kick-off a constructive debate. We welcome further suggestions from our readers so that we can use them as part of our anti-pollution campaign.

Annexure I

'We do produce polluting vehicles'

As the leading manufacturer of the leading polluter on Indian roads, the two-stroke two- and three-wheeler engine, RAHUL BAJAJ must shoulder a large part of the blame for air pollution in India. Two- and three-wheelers fitted with these engines, constituting 70 per cent of the country's total number of vehicles, belch out more than 65 per cent of the hydrocarbons present in the air in our cities. Industry, so far, seems to have remained indifferent. Critics allege that it has woken up to the problem only after the government presented it with inflexible deadlines to meet the emission standards.

The manufacturer of more than 50 per cent of these slow but steady gas bombs denies having committed an environmental crime by not addressing the problem soon enough, in an interview with Centre for Science and Environment.

BAJAJ AUTO LTD

Rahul Bajaj: Justifying himself on the grounds of providing mobility

You claim that your two-wheelers will be able to meet the emission standards for 1996 but not your three-wheelers. You have asked for an extension of the deadline till 1998, and a relaxation in hydrocarbon norms for three-wheelers. How has the government responded to your demand?

Let me make my position on this very clear. My existing three-wheelers cannot meet the norms. The alternative we had suggested, in consultation with the government, was a catalytic convertor. But convertors can be used only where unleaded petrol is available, and right now it is available in the four metropolitan cities only. But that is not under my control — the government cannot give us unleaded petrol all over the country.

But the government wants you to modify your three-wheeler engine design instead of using catalytic convertors to meet the 1996 standards.

The government is in the business of setting norms. It cannot dictate the technological route to us. But let me clarify. For over a year, we have been saying that we will meet the norms but we were not very sure whether we will be able to meet them by 1996. So we said we will meet the norms sometime in 1998. This is because we were not confident of the technical modifications we had introduced.

We have been saying this to the government not just for the last few months but for the last three years, because Mr Kamal Nath had told us, don't say you cannot meet the norms at the last moment. We have kept them informed that our two-wheelers would be able to meet the norms. But our three-wheelers would take time as we were not confident of the technological modifications that we were planning to introduce. We informed the government that if we cannot meet the norms with engine modifications, we will fit catalytic convertors provided unleaded petrol is available. We had asked for a concession in

the norms for hydrocarbon emissions where unleaded petrol is not available. We will meet carbon monoxide norms anyway. That stand remains on paper with the government. But what I am telling you now is that our work on modifying the two-stroke engine has been a success.

Does this mean that with these modifications your three-wheelers will meet the 1996 standards even without catalytic convertors?

Absolutely. We will meet norms by 1996 and now I am 95 per cent sure that there will be no problem. In fact, I am 100 per cent sure and I will know the position very soon.

Does this also mean that you do not need concessions in the hydrocarbon emission standard?

Look, I have been maintaining one position with the government for the last four months. If unleaded petrol was available all over the country, then I would not need any concession at all. But since unleaded petrol is available only in the four cities, convertors can be used there. For the rest of the country, we will need a concession in the hydrocarbon standards. But let me emphasise this — I am changing that position now. What I am telling you now is that all that may not be necessary. We may not need to fit vehicles with catalytic convertors even in the four metropolitan cities. We have been working on engine modifications for the last 18 months. *That exercise fortunately has very good news for us. We have been very successful and we will be able to meet the norms.*

Critics also feel that the 1996 emission standards suggested for two- and three-wheelers may only make a marginal impact on the air quality since they are not stringent enough, and that the increasing volume of traffic every year may negate even the little progress made with the enforcement of the 1996 norms.

It is not only a question of the 1996 norms — even the 2000 AD norms will not make any impact. Let any norm from anywhere in the world be brought in — let us say that all two-, three- and four-wheelers are emission-effective or are zero-emission vehicles, although that is technically impossible — the air in Delhi and Mumbai will still remain 95 per cent as bad as it is today.

The fact remains that all the present efforts by the government and the industry would still not rid the atmosphere of vehicular pollution. This is not because the norms are not stringent enough but because of the extremely large number of vehicles which have higher levels of emissions. The condition of maintenance of these vehicles, which is far from satisfactory, has a great influence on the emission level.

In another 10 years, the situation with badly maintained vehicles will worsen because of road and traffic conditions. If the government does not have the will to enforce a proper maintenance plan and corruption remains rampant, nothing will improve. Today, the political environment is such that it is difficult to enforce a plan of proper maintenance. The problem is that old vehicles do not get scrapped. No government in India can take a decision to scrap old vehicles. For heavens sake, we are not talking about replacing all old vehicles all over the country. I am happy with that, too, but no government can do that. They will be thrown out.

Nobody will listen either to us or the government. What we are therefore proposing in this case is that if older vehicles — say 5 to 7 years of age — are replaced and sold outside the four metros, in a few years time we will see a tremendous improvement in ambient air quality. But no government in India can take a decision like this. Everybody wants greenery and clean air but do not want to bear the costs. That's the problem in this country. They want somebody else to do something about it — *par khud kuch nahi karna chahte.* We start raising flags wanting others to do something but if we have to sacrifice, we backtrack.

Bajaj Auto Ltd has under its control about 50 per cent of the market in two- and three-wheelers. It is now a well established fact that two- and three-wheelers are responsible for almost 60 per cent vehicular pollution in India and they together account for about 70 per cent of the total number of vehicles. How will you react if we charge you with having committed an environmental crime by not taking corrective and adequate technical measures?

I will react to that frankly, depending on what context it has been raised.

The context is that the industry has not geared up in time to put in effect appropriate technological changes to reduce emissions which have serious health consequences.

Then I will maintain that any person saying that is completely ignorant. The person is very ill-informed and unaware of technological development in the industry.

We are also interested in a cleaner environment because we do not want you or our children to breathe dirty air. I have a lot of friends who get very excited and ask me what are we doing except for talking. *We tell them we are providing mobility to the people.* Nothing can take place without a sacrifice, without a trade-off. Otherwise, there cannot be any factory anywhere in the world.

As Indira Gandhi said, poverty is the biggest polluter. The green movement thinks the factory people are all subjective and prejudiced. Green people have a one-track mind. There is a lack of communication between the two sides, which is unfortunate. We know what we have been doing in this field for the last 10 years. We cannot keep explaining each and every detail to each and every person. A lot of people contact us, including the government. We still give a lot of time to supply information. No, we cannot agree to a possible charge of having committed an environmental crime.

What do you have to say in support of your claim that you have been proactive?

It is true that a large population of two- and three-wheelers exists in urban centres. But the responsibility of this cannot be fixed on Bajaj Auto Limited (BAL) alone. There are several other factors which are outside the control of BAL, such as the unavailability of mass or other alternative transportation system, the concentration of residential and business centres. BAL has only been providing the average middle-class person with a convenient and low-cost means of transport. If BAL has taken care of 50 per cent of this socio-economic requirement, we do not think it is a crime. In fact, our autorickshaws have replaced human and cycle-rickshaws and tongas over the last 25 years.

It would not be correct to say that BAL has not been taking adequate technical measures in time. On the contrary, we have been making proactive efforts to minimise the pollution from our vehicles in addition to meeting all the regulations which have been in force from time to time.

We are the only company in India who made an agreement with the well known Orbital Engine Co of Australia, as early as, 1989 to explore their environment-friendly technology. Please appreciate that there are several reasons why this technology has not been fully developed by Orbital till now and these are totally beyond BAL's control. You may note that this tie-up was made much before the mass emission standards were promulgated by the Indian government.

The problem of environmental pollution is acute mainly in the large urban areas where other factors such as road conditions, traffic density, existence of factories and other environmental conditions also play a part. Every type of transport vehicle using combustion engines pollutes the atmosphere. Different kinds of vehicles contribute different kind of pollutants. The total load of pollutants in the atmosphere depends upon the types and sizes of the engines used in these vehicles, the population of these vehicles in an area and their utilisation pattern.

Why hasn't the industry shown any independent interest in measuring ambient air quality to assess the impact of its own products? Only state agencies like pollution control boards and research institutions are currently involved in studying emission levels and advising government on pollution control measures. Do you consider this as one of the responsibilities of the industry? Will the industry be more participative in emission surveys in future? If yes, what are your plans?

The assessment of ambient air quality is not the responsibility of vehicle manufacturers. To our knowledge, this is the case in the whole world. The main reason for this is that there are several contributors to pollutants in the atmosphere, and assessing and monitoring this is an extremely complex task. In fact, this is a science in itself and in this the vehicle manufacturer does not have much expertise. Also, measurement of emission levels done by the industry may not carry much conviction.

Critics point a finger at the slow technological progress of the Indian two-wheeler industry, alleging that the scale of the market does not justify this slow pace. How would you respond to this?

We do not agree with the view that technological progress of the two-wheeler industry, particularly with respect to BAL, has been slow. Let me point out that the 1996 emission norms for two-wheelers are more stringent than the corresponding norms in European countries. The current Taiwanese norms are a little more stringent but it must be remembered that Taiwan has met these norms by extensive use of catalytic convertors, whereas we have been able to achieve the 1996 norms through more complex technological solutions rather than the relatively simpler but expensive catalytic convertors.

What are the constraints on research and development (R&D)?

I believe that we have the largest and the most advanced R&D setup. We have built up good resources during the last few years. However, we recognise that our R&D capability to develop new products and new technologies is not comparable to that of major two-wheeler manufacturers abroad, and with research organisations abroad who specialise in the field of internal combustion engines.

To the best of our knowledge, even the large two-wheeler manufacturers abroad, whose research and development set-ups are much bigger than ours and much more experienced, take assistance from specialist research organisations. We are also in touch with research organisations abroad to help us keep our vehicles technologically updated. We are confident that our vehicles will meet the April 1996 norms. We are also taking steps to make sure that all our vehicles meet the proposed norms for the year 2000 which, as of now, are as stringent as the rest of the world.

What kind of time-frame would the industry need to make the necessary technical adjustment and speed up progressive implementation of stricter emission standards?

As far as the present time-frame for tightening up the emission standards is concerned, *that is*, the 1996 and 2000 AD norms, they are generally acceptable to us and we are gearing up to fulfill these requirements in the allotted time-frame.

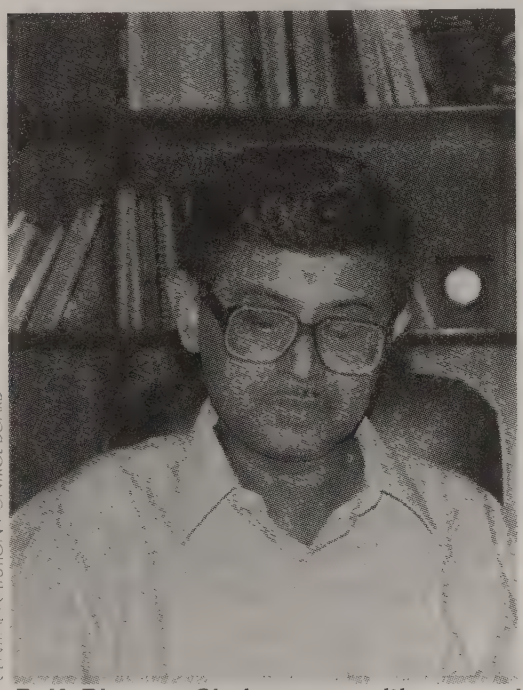
So you feel none of the criticism hurled at you is justified?

None of the criticism is justified. We do not expect to get a medal for having done a great job, because we do produce polluting vehicles. We are conscious of that difficulty. But we do expect an understanding that we have a role to play in producing vehicles — otherwise the government can say that vehicle production in the country should stop.

Annexure II

'I need implementing powers'

The Central Pollution Control Board — one would expect an organisation with a name like that to penalise polluters and care about the quality of air that citizens breathe. But this interview with CPCB chairperson D K BISWAS, shows that the CPCB is merely a lapdog of the Ministry of Environment and Forests, and all it can do about the deteriorating air quality in urban areas is "write letters".



D K Biswas: Chairperson with no real powers

What has the CPCB done about the increasing air pollution from vehicles in Indian cities so far?

Two or three major things. One, we cannot have better air quality without improving fuel quality. Two, we must improve the vehicles. So the major stress has been on improving fuel quality, both solid and liquid, and on emission standards for 1996 and 2000 AD. The other things needed are associated measures. For example, road conditions and traffic signalling systems have to be improved. *God knows who is going to do all this. We are addressing it to some people, without really knowing who will do what.*

We have started a vehicular emissions campaign together with the transport commissioners and vehicle manufacturers. They are supporting minor measures. The major one will be to improve the quality of vehicles. They must be made progressively more fuel-efficient and less polluting.

This is why we have suggested standards for two different periods — one for 1996 and another for 2000 AD, so that they can be made progressively stringent. We are assuming that to meet the 2000 AD standards, the automobile industry will move away from the age-old technology based on carburettors. We are also assuming that the auto industry will no longer produce two-stroke engines. In any case, they are selling their products abroad, where they are meeting the standards required by those countries. So why can't they do it here?

Isn't it because you are being too kind to them and letting them get away with lax standards?

No. It is because we have provided a very sheltered market for our industries in which consumers have no choice. As a result, the industry has had no pressure to change.

But why hasn't the government put pressure on them to produce better quality cars?

In the days before liberalisation, it was not believed that the Indian industry should face competi-

tion from outsiders. We believed that we must provide protection, no matter what the Indian industry produces. So quality was not of much concern. Only recently, particularly because of pollution problems and because of the globalisation policy, this kind of quality consciousness has come in.

Even today, if you ask me, neither the consumers nor the producers are quality conscious, except when there is a pinch. That is why our government's Ecomark is not gaining ground. There has to be pressure. Like the time when the Germans said we will not purchase Indian leather goods if they contain azodyes, and immediately the leather industry changed to cleaner dyes.

Why is the pressure not coming from within the country, from the government?

Government alone cannot do it. You need public pressure.

But you are the people who set regulations.

We cannot set regulations without public support.

Don't these regulations need to be based purely on technical findings? Why should they need public support?

'Technical' doesn't mean anything. I can go on suggesting many things. But if there is no build-up of pressure to implement them, nothing will happen. If you ask me, I would love to have a zero-emission vehicle. I would like to set that as a standard.

Then what are the pressures which prevent you from doing so?

The country was not ready so far. Earlier when we talked about the environment, people used to laugh at us. Even today when we talk about emission standards, the automobile manufacturers say the government is setting standards that are not implementable.

But you called their bluff once and it worked. You told the manufacturers they could either meet the standards or go off the market and they came up with an alternative. The two-stroke industry suggested the use of catalytic convertors but you did not agree and Bajaj Auto Ltd has come up with an alternative. So you have probably been too soft on them.

You have to understand that we are living in a democratic country. Our country does not have a dictator. Which is why we must have a response from the industry as well as the public. Even with catalytic convertors in cars, we have received so many complaints saying the government has done a wrong thing. We have to convince the public that it is required. If the price of a car with a catalytic convertor was even one paisa more, we would have heard no end to it.

But do you think that the automobile industry is doing its bit in terms of R&D and providing the best and least polluting technology?

It is not just the industry that can be blamed for this. Our public consciousness is also lacking. We talk about the environment but when it comes to paying for the environment, we're not willing to pay a single extra paisa.

How many people in India have access to information about the air they breathe in? How much is your organisation willing to tell them? Your organisation is responsible for doing research and objectively deciding what is the best option, and making these reports public. You have to safeguard public interests.

That is precisely what we have been doing. Over the years we have generated data, prepared reports and launched public awareness programmes.

But yet when we wanted basic data on air pollution levels in the three Indian metros, we couldn't get it all from CPCB.

But, see, India is a huge country.

But I am only talking about the three major metros of the country?

Suppose you ask me to give the data of Calcutta and all its polluting sources or if you ask me to give you a source-wise inventory of Delhi, it is almost impossible for me to do so. Even a country like the US has not done it.

I wanted just basic data — not even a source-wise inventory.

Basic data is not lacking.

Take a look at your National Ambient Air Quality Statistics publication. If I want data on the SPM level of any city, I just won't find it there. It seems to have been designed to confuse rather than inform. And there is no data analysis there — it is just raw data.

That is the problem with technical people. I tell my colleagues, you don't know how to write reports. Unfortunately our people don't know how to write in a language that the people will understand. That is why I am bringing out this *Parivesh* newsletter. You must have seen some copies. Its language is completely different from what is used in our other documents. I write it myself. The technical people should know the language in which to communicate but most of them don't.

Has the CPCB done any work to identify the causes of air pollution?

Oh yes, many such studies have been done.

What has been the follow-up on them?

The CPCB has been given the responsibility of generating data but not the responsibility for implementation.

But doesn't the CPCB have any enforcement powers?

No. This is the problem. Many people think that because it is the Central Pollution Control Board, it is an enforcement body. It is not true. That is why I have told the ministry to give me implementing powers.

Doesn't the Environment Protection Act (EPA) give you enforcement powers?

No, that is totally wrong. At the most I can request a state pollution control board under Section 18 of the EPA. If they don't comply, I can't do anything. So this is a toothless provision. This is why I have asked the ministry to give me powers where I can quickly deal with defaulters.

At the moment, CPCB is only a central advisory body producing enough technical information. *But when it comes to doing things, it is not up to the CPCB, even in the area of air pollution.* I can't ask the state transport authorities to do anything. At the most, I can ask the state pollution control boards. The state pollution control boards also turn back and say this is not their responsibility. In most cases we go about it in a very surreptitious way. Like I am doing now, talking to you. Or we provide information to the

Supreme Court. Because we don't have the powers to act, we go through NGOs and the media. But now that the Supreme Court has reposed some confidence in us, we are producing a mammoth amount of information.

So do the state pollution control boards have more power than you?

Yes, that's true.

But isn't it a pity that the Supreme Court has to pass orders on subjects that the Ministry of Environment and Forests (MEF) should be taking a strong stand on?

That is because the executive system of this country does not have enough powers. *We have set up a pollution control board without any teeth. This is why I asked Mr Rajesh Pilot, the Minister for Environment and Forests, what are you going to do?*

You are asking me to take action but what action can I take, except for writing a letter? Everyday I keep on writing letters — 50 or 60 letters of complaints. But if they don't comply, what can I do? I require powers under Section 5 of the EPA so that I can directly deal with them. I have suggested that the CPCB should be modelled along the lines of the Environmental Protection Agency of the US. I said this to Kamal Nath, the earlier Minister of State for Environment and Forests, immediately after I joined the CPCB. He agreed but did nothing. Pilot also agrees. He announced that changes will take place, but things are yet to happen.

You say there must be planning. But why do we have trouble with policy decisions that do get taken finally? Take catalytic convertors, for instance — why didn't we have the foresight to realise that there would be a problem with the availability of unleaded fuel and that the quality of convertors being imported needs to be controlled?

Because we have agencies in this country with a multiplicity of responsibilities. If the CPCB was told that this is its responsibility and its words will be directly binding on offending agencies, we would be more effective.

Do you have a list of priorities according to which you can say that certain things need to be addressed first?

We have presented a list of environmental action points to our new minister.

And where does air pollution figure?

On air pollution, we suggested that fuel quality improvement should come first and then emission control.

But have you done any study which shows that fuel quality is one aspect that needs to be targeted first and that is where the impact would be the greatest?

Our purpose is not to do academic exercises. We are told we must identify the priority. But what do we mean by priority? I am seeing it right in front of my eyes. Why should I do prioritisation and spend a few lakh rupees doing so?

But isn't it important to prioritise your action points? Especially if you are working with limited funds?

No, you don't need to. In the case of vehicular pollution we cannot say that we will only improve

the fuel quality and not do anything about motor vehicles, or not do anything about roads. All these things have to be done together.

So are you looking at traffic planning?

Yes, certainly. In fact, I wrote a paper on traffic planning in the *Hindu* daily's *Survey on the Environment, 1993.*

What have you done about it?

That is the problem with you people. You expect the CPCB to do traffic planning also. We can keep on writing letters but that does not build up pressure. Pressure is built up when what I say becomes legally binding. I can then put pressure to some extent. I can't go in front of the Ministry of Environment and Forests (MEF) and start shouting. I can't go to court against the MEF. That is not how this organisation is structured.

In that case you should have an organisation that is totally aloof from the MEF.

Mind you, I am in the MEF, as an organisation of the MEF. I can go only upto a certain limit. Beyond that I cannot go and shout and say the MEF is not doing anything.

You can't say that?

No. You must admit it. What we require is a body involving all relevant ministries, as appears to be happening now. For fuel quality I had a committee set up at the instance of the MEF, and all the representatives were there.

Why haven't the 1996 standards been notified as yet, even though the year has already started?

I don't want to argue on that. Talk to the Ministry of Surface Transport about that. I don't think that I can talk to you on such issues.

But shouldn't it be part of CPCB's agenda to see to it that the standards are notified in time?

I have reminded the ministry over and over again that this notification is long overdue. My job is to tell the ministry what should be done, not to news people.

I am asking you as a citizen.

I am telling you I have written not less than 20 letters: Not less than 20 times, both to the secretary and the minister that this has to be done. In fact I have even said 30 days are now left, 27 days are left.

Have any studies have been done on health effects of air pollution?

Again, let me ask you — how much is an organisation like CPCB expected to do?

But this is pollution that is having an adverse effect on people's health.

Then should I not take care of the hospitals as well? When we set standards, we don't set them just like that. We do a study, though not in the sense of a rigorous epidemiological survey. Looking at the kind of humanpower and facilities we have, if we got into epidemiological surveys, we would be doing only that for years together and not get anything out of it in the end. Health studies are not so easy. People think we can relate one-to-one like sulphur dioxide vs direct health effects.

But don't you think that it is shocking that we have pollution-related health problems and no studies which can tell us how bad the situation is?

No, it is not shocking. And, anyway, who says there are no studies?

There is not one study done in recent years which gives me a clear idea of how vehicular pollution is affecting health.

That is where our medical scientists are failing. If it is a health issue, the Ministry of Health should come forward and say we will do a study. And if they need help with funds and things like that, certainly we can help.

You can also go and tell them that such a study needs to be done.

We have. Who says we have not? These are basic things, I say.

Have the fuel quality standards proposed by a committee chaired by you been notified under the EPA yet, to make them compulsory for all refineries?

No, not yet.

Why not?

Because again the Ministry of Petroleum has some problem with it.

About air quality monitoring, why don't you measure benzene and ozone levels in the country?

We are barely able to monitor the key pollutants; that is more important now than monitoring benzene and all that.

But aren't benzene and tropospheric ozone health hazards?

They are not a problem.

There is a WHO study which says that tropospheric ozone could be a major problem in Delhi.

Unfortunately, that is not correct.

What modifications would be needed to vest the CPCB with more powers?

Number one, modify the EPA. Number two, our instructions should be obligatory on others — that a piece of advice from us is not taken just as a piece of advice, but as a directive. In fact, I have suggested that if we commit a mistake, there should be an appellate authority to check us — a separate group to make the CPCB also transparent and accountable. CPCB should also be answerable. Between the ministry and the CPCB, this division of work must be there. Not that this will solve all problems, but it will help.

Annexure III

Of the Highest Priority

After a 1992 World Health Organisation (WHO) Commission on Health and Environment identified air pollution in the world's cities as a major environmental health problem deserving action of the highest priority, WHO and United Nations Environment Programme (UNEP) initiated a study of air quality in 20 of the 24 megacities of the world. The urban areas chosen included two in North America, four in central and south America, one in Africa, eleven in Asia and two in Europe.

Though the report focussed on all sources of air pollution, it found that in the megacities, motor vehicles are a major source of pollution, and in nearly half of them, it is the single most important source. Cities like Bangkok, Manila, Mexico, Sao Paulo and Seoul have overwhelming traffic-created problems, with high carbon monoxide, hydrocarbons, nitrogen oxides and lead emissions. The general assessment of the report by WHO and UNEP is presented in this annexure.

Subjective assessment of the status of monitoring capabilities and availability of emissions inventories in 20 megacities (1992)

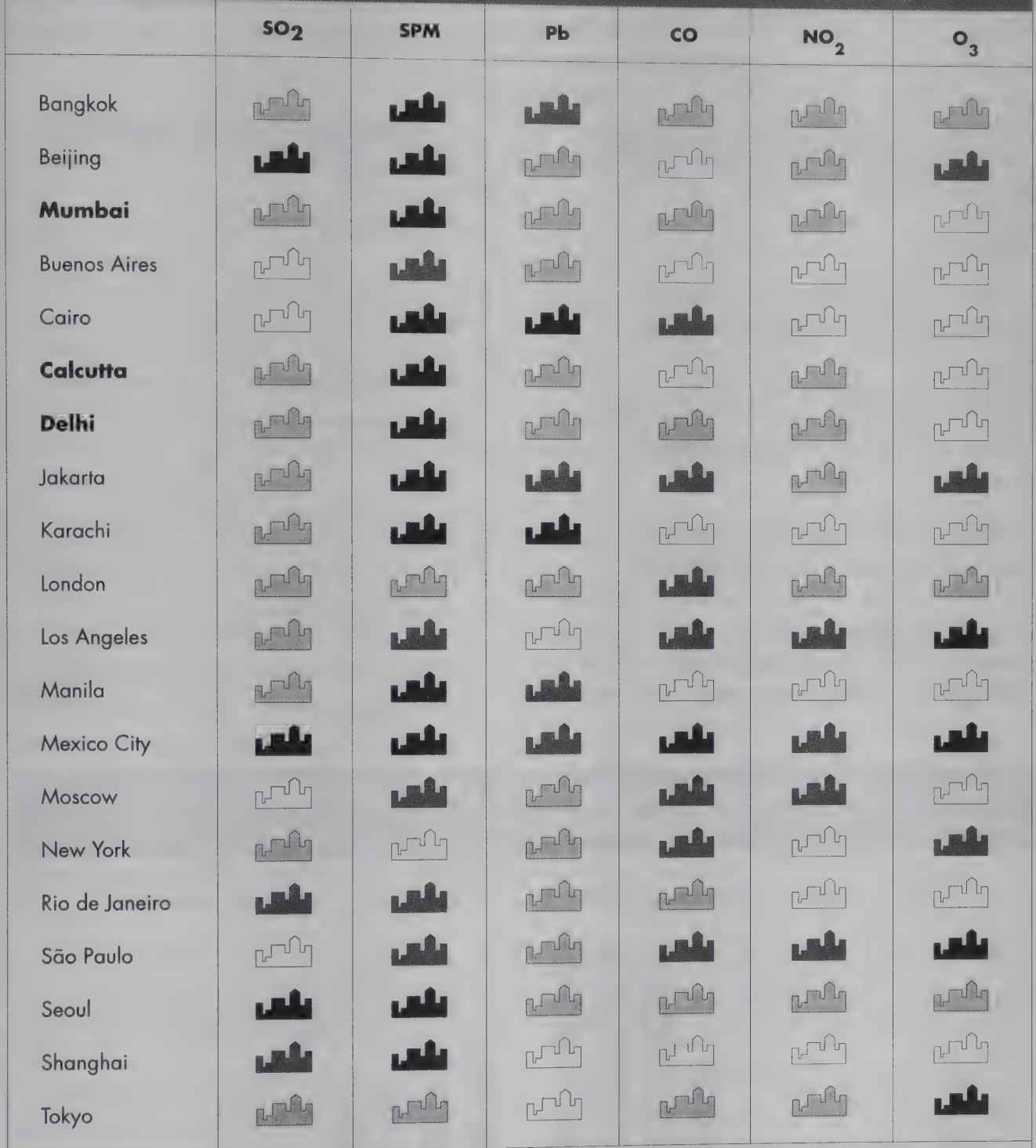
	SO_2	SPM	Pb	CO	NO_2	O_3	Emissions inventory
Bangkok	●	●	▼	▼	▼	■	■
Beijing	●	●	▼	▼	▼	▼	▼
Buenos Aires	◆	▼	◆	◆	◆	◆	■
Cairo	■	●	◆	◆	◆	◆	■
Calcutta	▼	▼	■	◆	▼	◆	▼
Delhi	▼	▼	■	◆	▼	◆	●
Jakarta	▼	▼	◆	◆	◆	◆	▼
Karachi	◆	◆	◆	◆	◆	◆	▼
London	●	▼	▼	■	▼	▼	●
Los Angeles	●	●	●	●	●	●	■
Manila	▼	▼	●	◆	◆	◆	●
Mexico City	●	●	◆	●	●	●	■
Moscow	◆	■	■	■	■	◆	●
Mumbai	▼	▼	■	◆	▼	◆	■
New York	●	●	●	●	●	●	■
Rio de Janeiro	●	●	■	▼	◆	◆	●
São Paulo	●	●	■	●	●	●	▼
Seoul	●	●	▼	●	●	●	▼
Shanghai	●	●	▼	◆	◆	◆	▼
Tokyo	●	●	◆	●	●	●	●

◆ None or not taken ▼ Adequate ■ Rudimentary ● Good

Notes: SO_2 : sulphur dioxides SPM : suspended particulate matter Pb : lead
CO : carbon monoxide NO_2 : nitrogen dioxide O_3 : ozone

SOURCE: UNEP and WHO, *Urban Air Pollution in Megacities of the World.*

Overview of air quality in 20 megacities based on a subjective assessment of monitoring data and emissions inventories (1992)



Notes: SO_2 : sulphur dioxides SPM : suspended particulate matter Pb : lead
CO : carbon monoxide NO_2 : nitrogen dioxide O_3 : ozone

SOURCE: UNEP and WHO, Urban Air Pollution in Megacities of the World.

The UNEP and WHO report *Urban Air Pollution in Megacities of the World* also has a situation analysis of three Indian cities — Calcutta, Delhi and Mumbai. The analysis is based on data from the National Environmental Engineering Research Institute (NEERI), Nagpur and is different from the Central Pollution Control Board (CPCB) data, highlighting the conflict in information on air quality status in India.

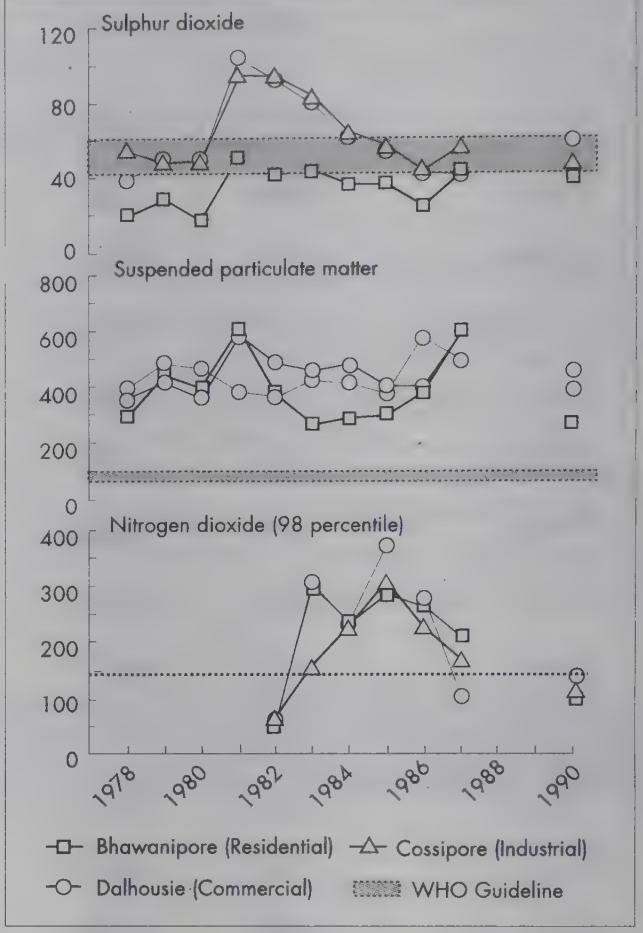
Calcutta

Estimated Population 1990: *11.83 million;*
Projected Population 2000: *15.94 million;*
Area: *1,295 km²;*
Motor Vehicle; Registrations: *500,000 (1989);*
Industry: *Heavy engineering, chemicals, jute, textiles;*
Energy: *Two thermal power plants. Coal is the major fuel source.*

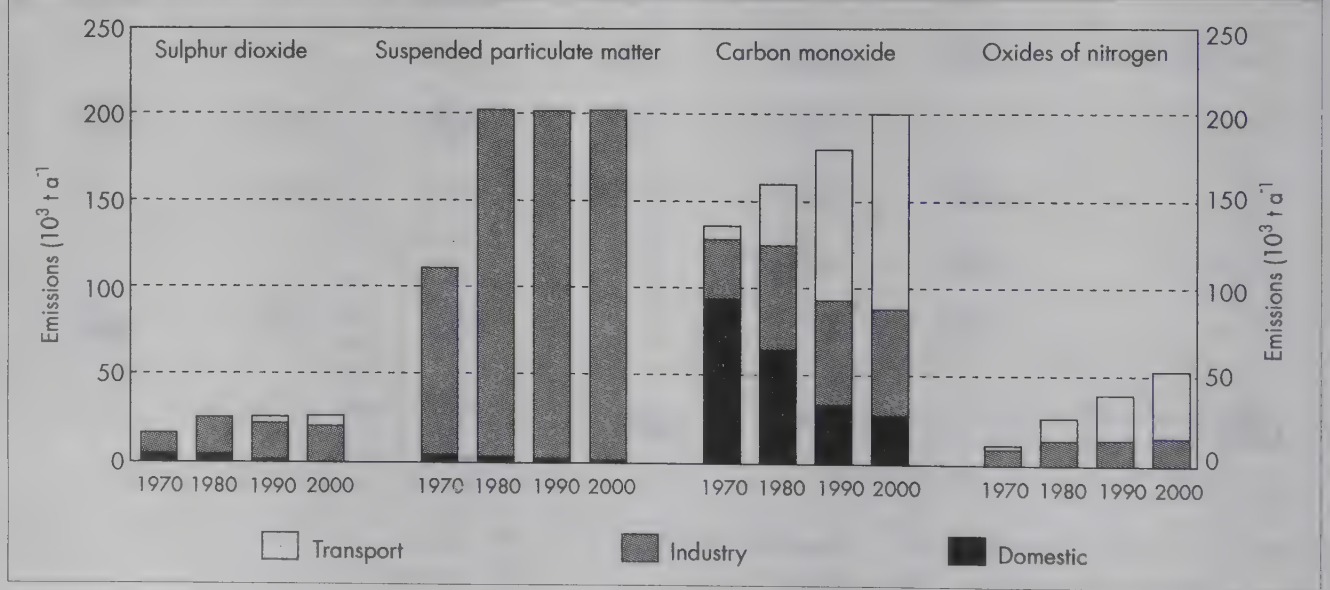
Calcutta has the largest urban population in India and overcrowding is a major problem.

Sulphur dioxide (SO_2) levels are surprisingly below WHO guidelines owing to the low sulphur content of local coal. Suspended particulate matter (SPM) from industrial burning of coal represents

Annual mean SO_2, SPM and NO_2 concentrations in Calcutta



Estimated and projected anthropogenic pollutant emissions in Calcutta by source, 1970-2000 (thousand tonnes per annum)



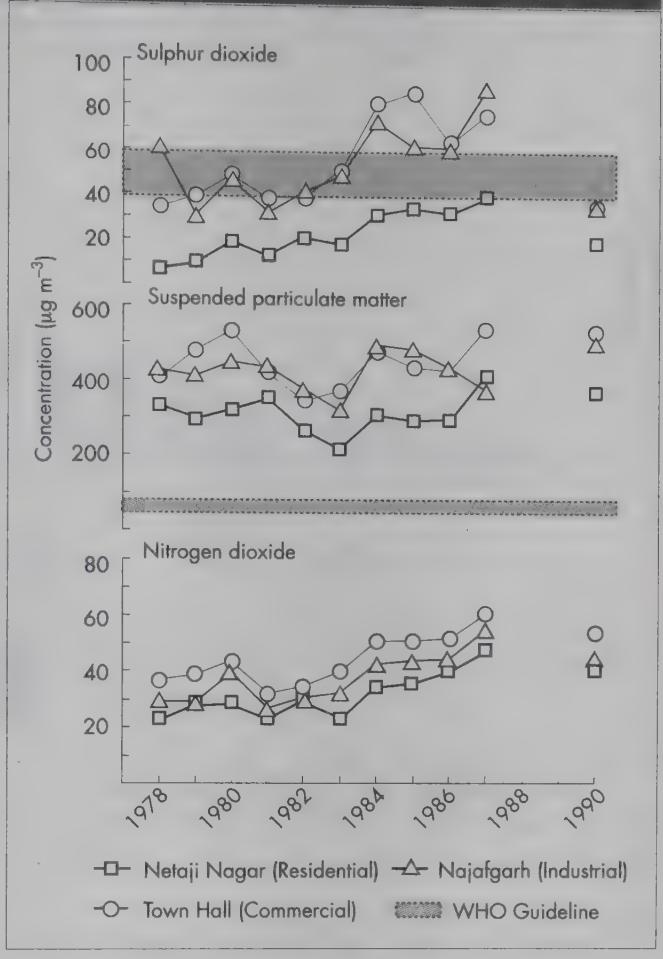
the greatest air pollution problem in Calcutta. Ambient annual mean SPM concentrations are over five times the WHO guideline. Industrial emisions have stabilized and might even decline over the next 10 years.

Lead (Pb), carbon monoxide (CO) and ozone (O_3) are not monitored regularly and although annual 98 percentile nitrogen dioxide (NO_2) concentrations exceeded the WHO guidelines at two out of three sites in 1987, but by 1990 were well below guidelines.

Motor vehicle emissions are of increasing concern although, at present, Calcutta has a relatively low motor vehicle population. Motor vehicle registrations are doubling every six years. Strict vehicle inspection and improved traffic management are required to help to slow down increasing emissions.

Cleaner coal burning is a necessity in order to reduce SPM emissions from domestic and industrial sources. The apparent high incidence of respiratory disease associated with air pollution should be urguently examined.

Annual mean SO_2, SPM and NO_2 concentrations in Delhi



Delhi

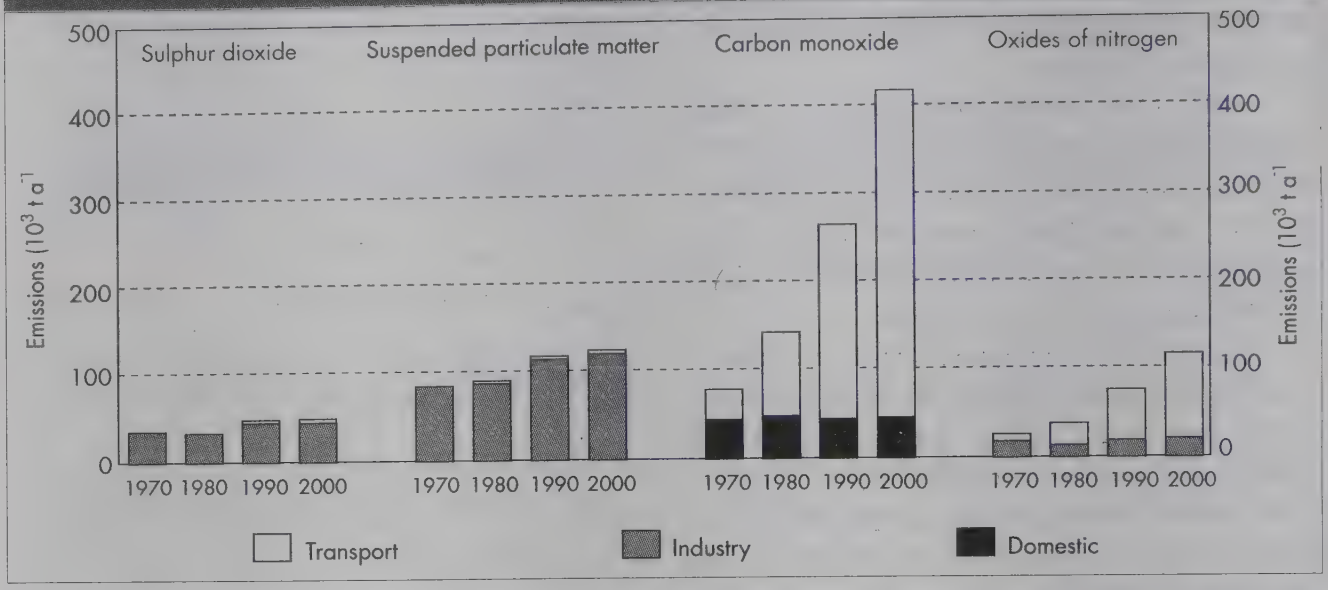
Estimated Population 1990: *8.62 million;*
Projected Population 2000: *12.77 million;*
Area: *591 km²;*
Motor Vehicle Registrations: *1,660,000 (1989);*
Industry: *Service industries, engineering, clothing, chemicals;*
Energy: *Two thermal power plants. Coal is a major fuel source, two power stations in city.*

India's capital Delhi is a rapidly expanding centre of government, trade, commerce and industry. Dust storms are a regular climatic feature; these deposit large amounts of suspended particulate matter (SPM) in the city's atmosphere. Delhi has a high motor vehicle population compared with other Indian cities.

Sulphur dioxide (SO_2) concentrations regularly exceed annual and daily WHO guidelines at commercial and industrial stations. A significant upward trend in SO_2 concentrations has been observed between 1978 and 1987, but isolated 1990 data suggest that concentrations have decreased to below the WHO annual guidelines. Suspended particulate matter concentrations are well above WHO annual guidelines and 98 percentile concentrations show an increasing trend between 1982 and 1987.

The concentration of lead (Pb) is below the WHO guidelines and despite Delhi's large motor vehicle population, NO_X concentrations are relatively low. But nitrogen dioxide (NO_2) and CO levels are

Estimated and projected anthropogenic pollutant emissions in Delhi by source, 1970-2000 (thousand tonnes per annum)



increasing each year and this trend will continue due to increasing motor vehicle numbers. Ozone (O_3) and CO are not routinely monitored so their risks are difficult to evaluate.

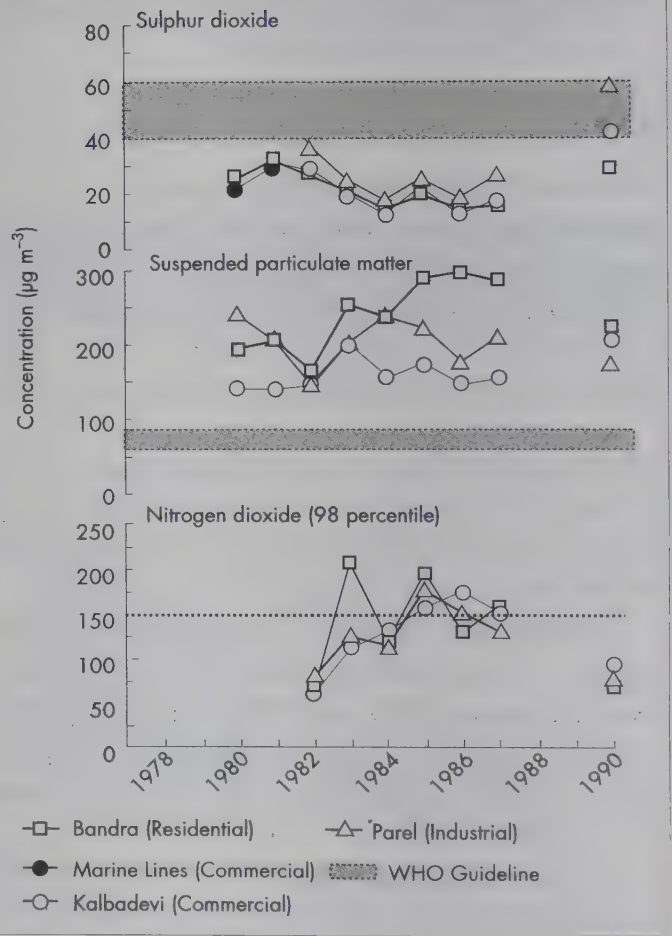
Changes in fuel use have helped to stabilize emissions from commercial and domestic sources. However, the rapid rate of industrial expanision means that emissions from this source are likely to rise. Overall, Delhi's air quality is likely to deteriorate rapidly over the next decade and epidemiological data is urgently needed.

Mumbai

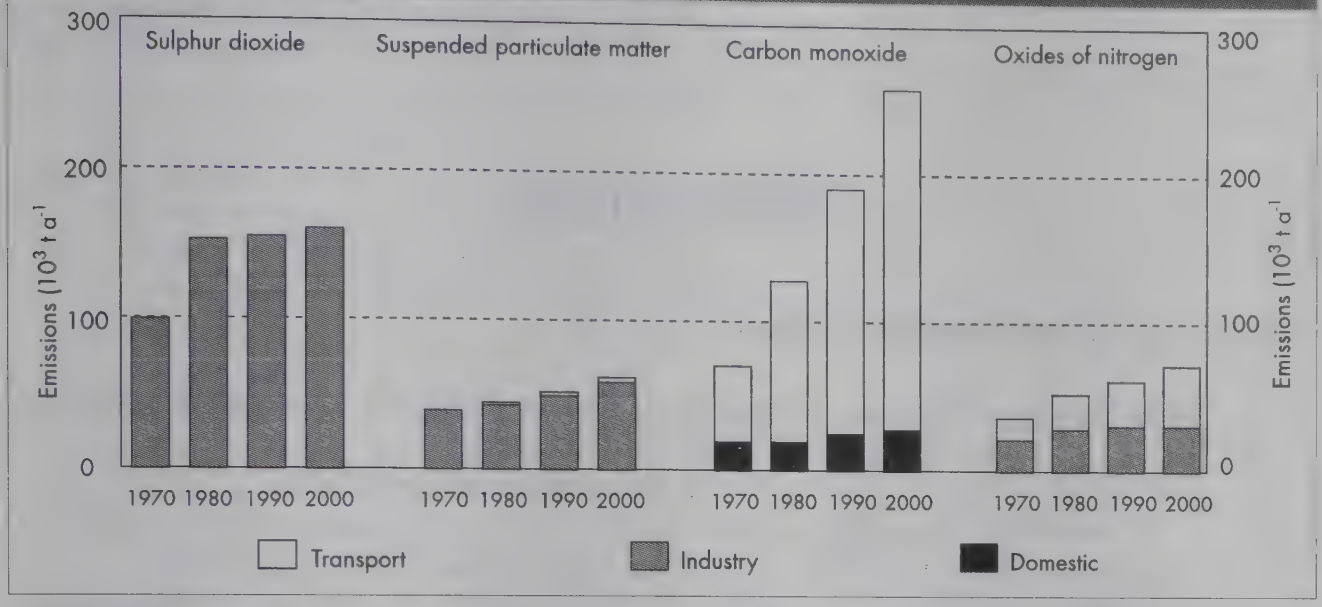
Estimated Population 1990: *11.13 million;*
Projected Population 2000: *15.43 million;*
Area: *603 km²;*
Motor Vehicle Registrations: *588,000 (1989);*
Industry: *Textiles (cotton), chemical and engineering;*
Energy: *One thermal power plant. Natural gas is a major industrial fuel.*

Mumbai is the financial and commercial centre of India and is a major industrialized port. Urban spread is restricted because of the

Annual mean SO_2, SPM and NO_2 concentrations in Mumbai



Estimated and projected anthropogenic pollutant emissions in Mumbai by source, 1970-2000 (thousand tonnes per annum)



city's island location and its motor vehicle density is high considering the restricted area. The main air quality problems in Mumbai can be attributed to increasing industrial productivity and motor vehicle traffic.

Planning control measures and the introduction of natural gas have reduced sulphur dioxide (SO_2) emissions in Mumbai while amibient concentrations are now well below WHO guidelines. Suspended particulate matter (SPM) annual mean and 98 percentile concentrations exceed guidelines at all stations in all the years monitored.

Airborne lead levels have decreased over two decades to below WHO guidelines. NO_X and CO emissions are increasing in line with motor vehicle traffic. Since 1985 the WHO daily guideline for NO_2 has been regularly exceeded. Ozone (O_3) may be a health hazard.

An epidemiological study indicated deleterious health effects in areas of high air pollution, but more recent data are required to examine the current situation. Mumbai's authorities should continue to encourage industrial relocation out of the city and promote use of natural gas. Urbanisation should be slowed to allow infrastructure development designed to prevent worsening air quality.

Table 2.1 Estimated emissions, 1990 (tonnes per annum)

City	SO_2	SPM	CO	NO_X
Delhi	46,000	116,000	265,000	73,000
Mumbai	157,000	50,000	188,000	58,000
Calcutta	25,000	200,000	177,000	40,200

Notes: SO_2 : sulphur dioxide SPM : suspended particulate matter CO : carbon monoxide NO_X : nitrogen oxides

SOURCE: UNEP and WHO, *Urban Air Pollution in Megacities of the World.*

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Glossary

anti-knocking properties refers to those properties of fuel which reduce/prevent the knocking tendencies of the engine due to combustion

aromatics is a kind of hydrocarbon (the others being paraffins, napthenes and olefines) which is present in hydrocarbon fuels such as petrol or diesel oil

aromatic fraction refers to the proportion of aromatic hydrocarbon in fuel (petrol/diesel)

bad quality fuel leads to gum deposits when certain types of high boiling hydrocarbons present in the fuel deposit varnish and slush in the engine on oxidising, causing the valve to stick and plugs the piston ring, adversely affecting engine performance and fuel economy

blowby/crankcase emission are unburned/partially burned hydrocarbons that escape the combustion chamber past the engine piston and rings, and enter the crankcase from where they get discharged to the atmosphere through ventings provided for this purpose

calorific value of fuel refers to the amount of heat energy released due to the complete combustion of a unit volume of fuel

carbon residue indicates contamination of distillate fuel with residual fuels. Results in loss in burning efficiency due to carbon residue

carburettor is a device that mixes air and petrol in the desired proportion and supplies the mixture to the engine during the intake stroke in quantities that meet the mixture requirements of the engine at all times

carburettor bowl is the part of the carburettor which contains the fuel (petrol)

catalyst is a substance that alters the velocity of a chemical reaction and maybe recovered essentially unaltered in form and amount at the end of the reaction

catalytic convertor is a device that has a catalyst bed and is incorporated in the engine exhaust system. It converts harmful constituents such as carbon monoxide, hydrocarbons and oxides of nitrogen into more benign constituents like carbon dioxide, water vapour, nitrogen, etc when they flow over the catalyst bed/coating

cetane number indicates the ability of a fuel to ignite quickly after being injected into the cylinder of an engine

chassis dynamometer is a device which facilitates engine testing under the conditions simulating certain situations of road operation of the vehicle

cold start refers to engine condition when engine is started from cold

combustion chamber is the area in the engine where the combustion of the fuel air mixture takes place

cracking is the process by which complex hydrocarbons are broken down

crankcase houses the crankshaft of an engine where oil from hot engine parts is collected and cooled before returning to the engine by a pump

crankcase scavenge pump the crankcase compresses the air and then transfers it to the cylinder through a transfer port to drive out products of combustion in the cylinder and subsequently provides the intake charge

cylinder block the block in which cylinder liner is located

density aids in detecting/adulteration by comparison to fuel from a parent valve

driving cycle is that which simulates average road driving conditions, such as acceleration, cruising, deceleration, etc

exhaust emissions refers to exhaust pollutants emitted through the tail pipe of a vehicle. The principal exhaust pollutants are carbon monoxide, hydrocarbons, nitrogen oxides and suspended particulate matter

evaporative emissions are mainly volatile fractions of gasoline (hydrocarbons) that escape into the atmosphere from the vapour space above the liquid fuel in the fuel tank, carburettor bowl and through various vents in the intake system

four-stroke engine is an engine in which the cycle of suction, compression and combustion, expansion and exhaust, is completed in two revolutions of the crankshaft

fuel injection system is a system that distributes the fuel more evenly to individual cylinders by means of a pump so that more power can be developed and undesirable emissions are reduced

ignition is the process of starting a fuel mixture burning or the means of such a process

ignition timing refers to the time in crank degrees at which ignition is triggered

ignition temperature is the lowest temperature at which combustion of a substance begins when it is heated in air

intake system is a system through which air and fuel are drawn inside the engine cylinder during the suction stroke/intake impulse

knocking indicates that the combustion of fuel vapour in the cylinder is taking place too rapidly for efficiency

motor octane number (MON) is an underestimate of the anti-knocking characteristic and the fuel's performance at high speed and load

octane number is a rating which indicates the tendency to knock when a fuel is used in a standard internal combustion engine under standard conditions

octane quality is the anti-knock property of fuel. The higher the octane rating of the fuel, greater is the possibility of the engine's high compression operating without a knock

optimisation is the maximising or minimising of a given function possibly subject to some type of constraints

piston and piston ring piston reciprocates inside the cylinder. It is provided with compression rings that seal the space between the piston and cylinder liner

port design and optimization refers to the design, location, size of intake and exhaust ports/passages in two-stroke engines

potential gum is found when unsaturated hydrocarbons present in gasoline absorb oxygen from the air. The concentrations are small during manufacturing, but they could increase to harmful proportions during the normal storage period. They reduce engine efficiency

recirculation of blowby gas the hydrocarbon rich blowby gases are recycled to intake air system through a positive crankcase ventilation (PCV) valve so as to utilise the unburned partially burned hydrocarbons and reduce blowby emissions

reed valve is a diaphragm like valve which operates because of pressure differences on its two sides. It is employed in some designs of two-stroke engines used in two- and three-wheelers

reference fuel is a fuel that has a standard specified composition and is used for testing engine exhaust emissions as per specified standards

research octane number (RON) is an overestimate of the anti-knocking characteristic of gasoline under low speed and light-load driving conditions

two-stroke engine is an engine in which the cycle of suction, compression and combustion, expansion and exhaust is completed in a single revolution of the crankshaft. Due to this, the size, weight and cost of the engine per horsepower is reduced

scavenging is the removal of spent gases from the engine and replacement by a fresh charge or air

unleaded petrol refers to petrol without lead additive (unleaded petrol in India contains up to 0.013 gm/1 of lead)

volumetric measurement at idling refers to quantity of fuel air mixture during idling of the engine

vapour pressure for a liquid or solid is the pressure of the vapour in equilibrium with the liquid or solid

warm start refers to the warm condition of the engine when starting it

Abbreviations

AAUI	Automobile Association of Upper India
AIAM	Association of Indian Automobile Manufacturers
AIIHPH	All India Institute of Hygiene and Public Health
APSTC	Andhra Pradesh State Transport Corporation
ARAI	Automotive Research Institute of India
BAL	Bajaj Auto Limited
BAU	business as usual
BIS	Bureau of Indian Standards
BRPL	Bongaigon Refineries Private Limited
CAAA	Clean Air Act Amendment
CCs	catalytic convertors
CNG	compressed natural gas
CO	carbon monoxide
COP	Conformity of Production Tests
CPCB	Central Pollution Control Board
CRL	Cochin Refineries Limited
CRRI	Central Road Research Institute
CSE	Centre for Science and Environment
DCP	Deputy Commissioner of Police
DTC	Delhi Transport Corporation
EPA	Environment Protection Act
ETBE	ethyl tertiary butyl ether
FCC	fluidised catalytic cracking
FEVI	forced expiratory volume in one second
FVC	forced vital capacity
gm/l	grammes per litre
gm/m^3	grammes per cubic metre
GAIL	Gas Authority of India Limited
HC	hydrocarbons
HCVs	heavy carrier vehicles
HM	Hindustan Motors

HPC	Hindustan Petrochemicals Limited
IARI	Indian Agricultural Research Institute
IIP	Indian Institute of Petroleum
IIT	Indian Institute of Technology
IMVA	Indian Motor Vehicles Act
IOCL	Indian Oil Corporation Limited
kmph	kilometres per hour
KPa	Kilo Pascal
LCVs	light carrier vehicles
LEAP	Long Range Energy Alternative Planning
MCGB	Municipal Corporation of Greater Bombay
MCVs	medium carrier vehicles
MEF	Ministry of Environment and Forests
MON	motor octane number
MOST	Ministry of Surface Transport
MRPL	Mangalore Refineries and Petrochemicals Limited
MRTS	mass rapid transit systems
MTBE	methyl tertiary butyl ether
MUL	Maruti Udyog Limited
N_2	nitrogen
NCAER	National Council for Applied Economic Research
NEERI	National Environmental Engineering Research Institute
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
OCC	Oil Coordination Committee
OECD	Organisation for Economic Cooperation and Development
PAH	polyaromatic hydrocarbon
Pb	lead
PCU	passenger car units
PCV	Positive Crankcase Ventilation
PM10s	particles less than 10 microns in diameter
ppb	parts per billion
ppm	parts per million
PUC	pollution under control
R&D	research and development
RFG	reformulated gasoline
RITES	Rail India Technical and Economic Service Limited
RON	research octane number
RSPM	respiratory suspended particulate matter
Rvp	Reid vapour pressure
SO_2	sulphur dioxide

SPM	suspended particulate matter
STA	State Transport Authority
TAME	tertiary amyl ether
TEL	tetra ethyl lead
TERI	Tata Energy Research Institute
tpd	tonnes per day
TSP	total suspended particulates
ULP	unleaded petrol
VOC	volatile organic compounds
WHO	World Health Organization
$\mu g/m^3$	micrograms per cubic metre

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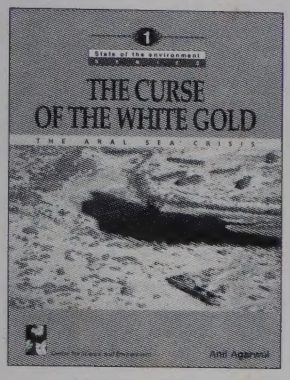

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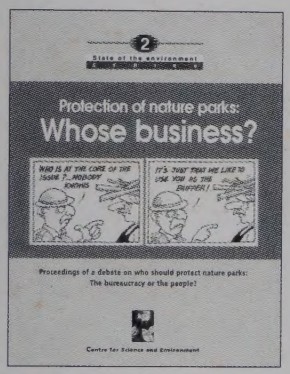

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